GERIATRIC AIRCRAFT: AIRCRAFT MAINTENANCE DURING AN ERA OF AGING COMMERCIAL FLEETS

HEARING

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

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CONTENTS

WITNESSES

June 4, 1986: Page

Jim Burnett, member, National Transportation Safety Board, accompanied by Bernard Loeb, Ph.D., Deputy Director, Bureau of Accident Investigation, National Transportation Safety Board 4

Anthony Broderick, Associate Administrator for Aviation Standards, Federal Aviation Administration 31

Benjamin Cosgrove, vice president—engineering, Boeing Commercial Airplane Co., Seattle, WA 52

William W. Hoover, executive vice president, operations and safety, Air Transport Association of America, Washington, DC, accompanied by Vern Ballenger, assistant vice president, engineering and maintenance . 66

GERIATRIC AIRCRAFT: AIRCRAFT MAINTENANCE DURING AN ERA OF AGING COMMERCIAL FLEETS

WEDNESDAY, JUNE 4, 1986

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON TRANSPORTATION,
AVIATION AND MATERIALS,
Washington, DC.

The subcommittee met, pursuant to call, at 9:35 a.m., in room 2325, Rayburn House Office Building, Hon. George E. Brown, Jr. (chairman of the subcommittee) presiding.

Mr. BROWN. The subcommittee will come to order.

I have a brief opening statement. And without objection, the subcommittee will approve of the presence of cameras to record the proceeding this morning.

Today, the Subcommittee on Transportation, Aviation and Materials will consider the issues of aging aircraft and aircraft maintenance during an era of aging commercial fleets.

In the last several years we have seen a significant transformation of the U.S. air transport system. The number of scheduled airlines has doubled, and the number of aircraft in operation has increased dramatically. At the same time, however, airlines are currently operating much older aircraft, airline industry maintenance budgets have declined and the FAA's maintenance inspection work force has decreased significantly. These are some of the trends that the subcommittee will examine during this hearing.

We are particularly interested in assessing the impact of the growing use of older aircraft fleets, looking at the technologies employed to determine the safety and useful life of aircraft, and reviewing the FAA's current system for assuring that aircraft are properly maintained. I might say on this point just as a personal note, which Congressmen sometimes are inclined to make, that Friday morning when I went to Dulles to make a 6:30 a.m. flight to California I was told the flight was canceled because of equipment problems. And if they really had problems, I am glad they canceled it; but it was nevertheless quite inconvenient to have it canceled at 6:30 in the morning. But I guess that is one of the problems with geriatric aircraft.

I would like to thank the witnesses who have agreed to appear before us today, and I look forward to an informative and productive hearing.

I would like to recognize our distinguished ranking minority member at this point for any statement that he may have.

Mr. LEWIS. Thank you, Mr. Chairman.

We have all enjoyed the advantages that free enterprise has brought to the airline industry, and few people today would want to return to the strict airline regulation of the past. However, not all the news has been good, and the time has come to step back, take a look at what has happened and assess one of the effects of deregulation, the aging fleet.

In today's business environment airlines have to find ways to cut costs to remain competitive. We should expect fewer frills if we want to lower airfares. I believe the public has made it clear that this is a choice they welcome. More people are flying today than ever before. And if the FAA's data on airline fatalities are any indication, we can still fly with confidence that the airlines are operating safely. And yet we hear with increasing frequency that some airlines have begun cutting corners in the area of safety to hold their costs down. Flying older airplanes is certainly one way of holding down costs, but this by itself shouldn't necessarily be viewed as unsafe. However, these older airplanes need more care, not less, as we are seeing today. These trends are indeed cause for concern.

Mr. Chairman, you are to be commended for holding this hearing today. We need to assure ourselves and the flying public that safety will not be sacrificed to pay for lower airfares. Surely the choice must not be between a tightly regulated industry and an unsafe transportation system. I look forward to hearing what our witnesses have to say on this subject today, Mr. Chairman. Thank you.

Mr. BROWN. Thank you, Mr. Lewis.

I would like to ask our distinguished former chairman of this subcommittee, Mr. Glickman, if he would care to make any statement at this point.

Mr. GLICKMAN. Thank you very much, Mr. Chairman. I want to compliment you for scheduling this hearing today.

Many of us have become very concerned about several disturbing trends in recent years. I am very concerned about the apparent inadequacy of the FAA's maintenance inspection system and workforce, particularly now that airlines are operating much older aircraft and devoting less of their operating budgets to maintenance. With much of the airline fleets now averaging around 10 years in age, and many aircraft in operation approaching or moving beyond the 20-year mark, now is the time to really concentrate on effective maintenance programs. Yet, the airline industry has cut the amount of resources devoted to maintenance from 11 percent of their operating budget to 7.4 percent. When you also consider that the FAA's maintenance inspection workforce has been cut 34 percent in the last several years, although I have see some trends that it will be increasing now, we can see that those trends are very alarming.

The recent GAO report which concluded that the FAA cannot say with assurance that airlines are complying with safety regulations was particularly disturbing, as well as recent NTSB reports

which indicate that ineffective FAA inspections contribute to aircraft accidents.

Because of these concerns, I have introduced legislation, H.R. 4403, to make it a criminal offense to falsify aircraft maintenance records and to increase civil penalties for violations of aviation safety regulations. That legislation was recently endorsed by the FAA and Justice Department.

I am hopeful that we can gain a better understanding of these issues today, and look for ways to set up a more effective system for assuring that older aircraft are safely maintained.

And just a quick parenthetical point, Mr. Chairman, on one of the spinoffs of deregulation. As new carriers enter the marketplace they can buy older airplanes much cheaper than new ones, so you see older DC–9's; older 727's, both the stretched and nonstretched variety; older propeller airplanes being utilized to transport people, sometimes under conditions which require dramatic utilization of those airplanes on a day-to-day basis. And I think one of the things in our hearings today ought to be to explore the useful life of these older airplanes, particularly as they are being utilized in ways that probably were not intended by their manufacturers.

The second point has to relate in the general aviation industry. We see an industry in which we are not selling very many new airplanes at all. In my own city of Wichita, Cessna laid off 1,000 people last week and announced that they will no longer produce piston engine airplanes for a while. Why? Because of the enormous market for used airplanes in this country. And of course we build airplanes very well in America, to last for a long time. But as these planes become 25, 30, 35 and 40 years old, the laws of nature finally catch up with them, and they can't last forever. And you see a lot of these very, very older airplanes having difficulties which, because of product liability reasons and insurance reasons, are making it more expensive to buy new airplanes. Because they are insuring these older airplanes. I think we ought to explore that as part of this hearing, too. The issue of geriatric aircraft as it relates to the general aviation industry, as well as it relates to the commercial airline industry.

Thank you very much.

Mr. BROWN. Thank you, Mr. Glickman, for those well-chosen remarks.

Before we call the first witness, I would like to apologize for the fact that we will have some perturbations in the hearing this morning as a result of the simultaneous hearing of the full committee for a mark up of several pieces of legislation. It may be necessary, in order to get a vote in the full committee, for us to recess temporarily during the course of the morning for that purpose, and we apologize in advance for the need to do that.

Our first witness will be Mr. Jim Burnett, National Transportation Safety Board, and we welcome him here this morning. Mr. Burnett, of course the full text of your statement will appear in the record, and you may present it in any fashion that you wish that you think will be most effective.

STATEMENT OF JIM BURNETT, MEMBER, NATIONAL TRANSPORTATION SAFETY BOARD; ACCOMPANIED BY BERNARD LOEB, PH.D., DEPUTY DIRECTOR, BUREAU OF ACCIDENT INVESTIGATION, NATIONAL TRANSPORTATION SAFETY BOARD

Mr. BURNETT. Thank you, Mr. Chairman. I will try to summarize my full statement.

Mr. Chairman, I would like to introduce to the committee, on my left, Dr. Bernard Loeb, who is the Deputy Director of our Bureau of Accident Investigation.

Mr. Chairman, and members of the subcommittee, I welcome the opportunity to be here today to share the Safety Board's views on the implications of aging airplanes in the U.S. airline industry.

The system of inspection and maintenance for ensuring the safety of the fleet as it ages has been basically sound thus far. However, with aircraft being utilized more and more in our deregulated airline industry, we do not want success in aviation safety over the years to lull us to sleep in our oversight of carrier maintenance practices. It is legitimate to wonder what an aging aircraft fleet means in today's highly competitive atmosphere.

Operating experience has shown that as airplanes become older they will require more frequent inspection of their structures for damage from fatigue and corrosion. This is because fatigue is flight cycle dependent and corrosion is time dependent. The longer the airplane is in service and the more takeoffs and landings it performs, the greater is the effect of factors such as fatigue cracking and corrosion on the structural integrity of the airplane. Thus, the extended use of airplanes could result in greater risk to the public if these airplanes are not adequately inspected and maintained.

However, with adequate inspection and maintenance the extended use of airplanes should not result in a degradation in safety. The key question then is, What is adequate? This is not easy to answer, but we should not assume that the frequency and type of inspections adequate in the early stages of an airplane's life will remain adequate as the airplane ages.

Federal regulations do not address directly the age of airplanes. Neither do they require a manufacturer to determine or estimate the fatigue life or safe lie for an entire airplane or its airframe. Manufacturers generally design planes to have a specific economic life during which airframes should not develop major fatigue cracks. It is important to bear in mind that this economic design fatigue life of an airplane is not based primarily on safety considerations.

Essentially, the design philosophy is that an airplane can be used forever provided continuing inspections show that the structure is not damaged by fatigue or corrosion. Safety is addressed through establishment of various inspection and maintenance reliability programs. It is the thoroughness and adaptability of those programs that determine the continuing safety of aging aircraft.

The Safety Board has investigated or participated in the investigation of many accidents and incidents in which airplanes experienced failures in their structure, flight control surfaces and landing gear because of fatigue cracks or corrosion. Some of the more serious of these occurrences include the decompression of a Boeing

707 because of cracks in the fuselage sidewall, depressurization of a Boeing 727 because of fatigue cracks in a floor beam flange, and the Boeing 747 has experienced a rear pressure bulkhead failure and fuselage cracks in the nose section.

In all, Safety Board data reveal that for the last 15 years fatigue or corrosion has been mentioned as a probable cause or related factor in only 35 of the 554 air carrier accidents that occurred during that period. These accidents included older propeller-driven airplanes, turboprop airplanes, and, of course, a few turbojet airplanes. Fatigue or corrosion was also mentioned 77 times during that period in 579 such air carrier incidents.

However, few of these accidents or incidents involved fatigue cracking or corrosion of the primary structure of turbojet transport airplanes. Further, there has not been one passenger fatality from an aviation accident in the United States in which the Safety Board has cited fatigue or corrosion in a turbojet as a cause or related factor.

I know, Mr. Chairman, that your subcommittee is concerned with the subject of aircraft maintenance in light of the deregulated environment in which the industry now finds itself. I can only say that, by and large, U.S. airline aircraft are maintained properly by the carriers; where they are not, the FAA should catch any maintenance deficiencies in its role as overseer of the industry.

However, a disquieting note is sounded by the fact that we at the Safety Board have found in aviation accidents instances in which there were deficiencies in FAA maintenance surveillance. Three such instances are illustrative of what can occur when deviations of standard airline maintenance practice are not detected by the FAA.

As we all know, in May 1979 an American Airlines DC–10 crashed shortly after takeoff from O'Hare Airport in Chicago when an engine detached from a wing, causing the loss of control of the aircraft. Contributing to the cause of this accident, we found, were deficiencies in FAA surveillance and reporting systems that failed to detect and prevent the use of improper maintenance procedures.

In February 1983, a Sierra Pacific Airlines DHC–6–300 crashed on a highway near Hailey, ID, when the captain lost the use of the elevator to maintain control of the airplane. Fortunately, there were no fatalities. Our investigation disclosed that a nonstandard bolt had been improperly installed in the elevator control linkage system. Contributing to the cause of the accident was the failure of the FAA to detect the company's deviation from approved maintenance procedures during surveillance inspections.

The third example involves the much publicized near tragedy that occurred in May 1983, when an Eastern Airlines L–1011 lost power in all three of its engines and began descending toward what looked like a ditching into the Atlantic Ocean. Fortunately, the captain was able to restart one of the engines and fly the airplane back to a safe landing. Our investigation revealed that due to improper maintenance O-ring seals had not been installed in magnetic chip detectors for each engine, resulting in major oil leaks in all of them. The Safety Board learned that the FAA had been aware of previous maintenance problems associated with missing O-rings, yet failed to assign a special surveillance priority to the problem.

Although, Mr. Chairman, none of these incidents involves the issue of aging airplanes, it does reflect on the ability of the FAA surveillance system to detect problems, and the ability to detect those problems in essential for maintaining the safety of our aging aircraft fleet.

Additionally, our information discloses at least 20 occurrences since 1980 in which improper maintenance was included as a factor to the probable cause. We have no way of knowing how much the economic pressures of deregulation may have influenced the carrier's actions. None of these occurrences has been attributed to aircraft age, per se. Most have resulted from inadequate or improper inspection or maintenance. Others were attributed to inadequate design. However, some of these did involve relatively high time airplanes.

The FAA's program to determine which components of the older turbojet airplanes designed under the fail-safe concept require more frequent inspection for fatigue is called the Supplemental Structural Inspection Program for large transport category airplanes. Aircraft manufacturers play a large role in this program, which is designed to adjust the frequency and method of inspections to assure continued airworthiness as airplane structures age. In essence, the program provides special attention to areas of the airplane not necessarily found to be of concern during the original structural analysis, as well as to areas that experience service difficulties—all to ensure continued structural integrity.

The program has produced results. Through it Boeing has identified significant structural items on the 727, 737, and the 747 that will require additional inspections as the airplanes age. Thus, the Supplemental Structural Inspection Program should provide protection against catastrophic loss of older planes from the fatigue failure of critical parts or components.

However, not all commercial airplanes are under such a program until all the inspection documents are complete, the continued airworthiness of these aging airplanes is being addressed through conventional service bulletins and airworthiness directives. Boeing I believe has completed the structural inspection documents on all—for all of its models of aircraft. However, I think McDonnell Douglas has only completed them for the DC–8 within the last few months and, for instance, the DC–10 will not be completed until June of 1988; and the L–1011, Lockheed will not complete their structural inspection document until, I believe, June 1987.

Proper inspection and maintenance is the key to continued airworthiness of aging airplanes and engines. Proper FAA surveillance of the implementation by airplane operators of their maintenance reliability programs is the key to the proper inspection and maintenance of the aging fleet.

Mr. Chairman, that concludes my formal statement. I will be pleased to respond to the questions of the committee.

[The prepared statement of Mr. Burnett follows:]

National Transportation Safety Board
Washington, D.C 20594

Safety Information

Statement of the

National Transportation Safety Board

by

Jim Burnett, Member

before the

Subcommittee on Transportation, Aviation and Materials

Committee on Science and Technology

House of Representatives

Regarding

Aircraft Maintenance Technology and Aging Fleets

June 4, 1986

Chairman Brown, Members of the Subcommittee, I welcome the opportunity to be here today to share the Safety Board's views on the implications of aging airplanes in the U.S. airline industry.

The system of inspection and maintenance for ensuring the safety of the fleet as it ages has been basically sound thus far. However, with aircraft being utilized more and more in our deregulated airline industry, we do not want success in aviation safety over the years to lull us to sleep in our oversight of carrier maintenance practices. It is legitimate to wonder what an aging aircraft fleet means in today's highly competitive atmosphere.

Airplanes are designed, certificated and manufactured in accordance with Federal Aviation Regulations (FARs) to provide many years of useful service. An evaluation of the strength, detail design and fabrication of the principal parts of most transport category airplanes in service today was performed by the manufacturer to demonstrate, in accordance with the fail-safe (or in some cases the safe-life) design concept, that they would not fail catastrophically from fatigue or corrosion damage. (Airplanes are designed with the presumption that they will sustain such damage during their service life.)

The fail-safe concept requires that in the event a principal structural component (a primary load carrying item) fails, the secondary or fail-safe load path, which will carry the redistributed load, has sufficient residual strength to support the ultimate loads expected. The safe-life concept requires that the structural component or part will not fail when subjected to the ultimate loads or that it will not fail within a specified period of time.

In 1978, the regulations were revised to require, except where impractical, the damage-tolerance of the airplane structure. Under this concept the manufacturer must determine the probable location and modes of damage from fatigue, corrosion or accidental damage, including damage at multiple sites from prior fatigue exposure. Evaluations must show that sufficient residual strength exists following damage of a component to permit the damage to be detected by inspection prior to failure of the part.

For an airplane to continue in an airworthy condition once it enters service, it must be operated, inspected and maintained in accordance with an FAA-approved maintenance reliability program developed through a Maintenance Review Board composed of representatives of the FAA, the manufacturer and operators.

Operating experience has shown that as airplanes become older they will require more frequent inspection of their structures for damage from fatigue and corrosion. This is because fatigue is flight-cycle dependent and corrosion is time dependent. The longer the airplane is in service and the more takeoffs and landings it performs, the greater is the effect of factors such as fatigue cracking and corrosion on the structural integrity of the airplane.

This is especially so for corrosion, which is highly dependent upon the environment in which the airplane is operated. Airplanes operated near salt air or sulphur producing industry develop corrosion problems before they

reach the fatigue limits of their structures. Thus, the extended use of airplanes could result in greater risk to the public if these airplanes are not adequately inspected and maintained.

However, with adequate inspection and maintenance the extended use of airplanes should not result in a degradation in safety. The key question then is, what is adequate? This is not easy to answer, but we should not assume that the frequency and type of inspections adequate in the early stages of an airplane's life will remain adequate as the airplane ages.

Federal regulations do not address directly the age of airplanes. Neither do they require a manufacturer to determine or estimate the fatigue life or safe life for an entire airplane or its airframe. Manufacturers generally design planes to have a specific economic life during which airframes should not develop major fatigue cracks. It is important to bear in mind that this economic design fatigue life of an airplane is not based primarily on safety considerations.

Essentially, the design philosophy is that an airplane can be used forever provided continuing inspections show that the structure is not damaged by fatigue or corrosion. Safety is addressed through establishment of various inspection and maintenance reliability programs.

A question -- one of many I will raise here today -- is whether or to what extent the continuing inspection program is able to assure the detection of problems which might develop as the airplane approaches and passes the economic design life criteria.

The Safety Board has investigated or participated in the investigation of many accidents and incidents in which airplanes experienced failures in their structure, flight control surfaces and landing gear because of fatigue cracks or corrosion. These occurrences include:

-- Decompression of the Boeing 707/720 because of cracks in the fuselage sidewall, flap failures and a horizontal stabilizer failure.

-- Depressurization of a Boeing 727 because of fatigue cracks in a floor beam flange; numerous other fatigue cracks and corrosion failures of landing gear components.

-- The Boeing 747 has experienced a rear pressure bulkhead failure and fuselage cracks in the nose section, which I will discuss in further detail later.

In all, Safety Board data reveal that for the last 15 years fatigue or corrosion has been mentioned as a probable cause or related factor in 35 of the 554 air carrier accidents that occurred during that period. These accidents included older propeller driven airplanes, turboprop airplanes and the more modern turbojet airplanes. Fatigue or corrosion was also mentioned 77 times during that period in 579 such air carrier incidents.

However, few of these accidents or incidents involved fatigue cracking or corrosion of the primary structure of turbojet transport airplanes.

Further, there has not been one passenger fatality from an aviation accident in the U.S. in which the Safety Board has cited fatigue or corrosion in a turbojet as a cause or related factor.

I know, Mr. Chairman, that your subcommittee is concerned with the subject of aircraft maintenance in light of the deregulated environment in which the industry now finds itself. I can only say that, by and large, U.S. airline aircraft are maintained properly by the carriers; where they are not, the FAA should catch any maintenance deficiencies in its role as overseer of the industry.

However, a disquieting note is sounded by the fact that we at the Safety Board have found in aviation accidents instances in which there deficiencies in FAA maintenance surveillance. Three such instances are illustrative of what can occur when deviations of standard airline maintenance practice are not detected by the FAA.

As we all know, in May of 1979 an American Airlines DC-10 crashed shortly after take-off from O'Hare Airport in Chicago when an engine detached from a wing, causing the loss of control of the aircraft. Contributing to the cause of this accident, we found, were deficiencies in FAA surveillance and reporting systems that failed to detect and prevent the use of improper maintenance procedures.

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investigation disclosed that a nonstandard bolt had been improperly installed in the elevator control linkage system. Contributing to the cause of the accident was the failure of the FAA to detect the company's deviation from approved maintenance procedures during surveillance inspections.

The third example involves the much-publicized near-tragedy that occurred in May 1983, when an Eastern Airlines L-1011 lost power in all three of its engines and began descending toward what looked like a ditching into the ocean. Fortunately, the captain was able to restart one of the engines and fly the airplane back to a safe landing. Our investigation revealed that due to improper maintenance, O-ring seals had not been installed in magnetic chip detectors for each engine, resulting in major oil leaks in all of them. The Safety Board learned that the FAA had been aware of previous maintenance problems associated with missing O-rings, yet failed to assign a special surveillance priority to the problem.

Additionally, our information discloses at least 20 occurrences since 1980 in which improper maintenance was included as a factor to the probable cause. We have no way of knowing how much the economic pressures of deregulation may have influenced the carrier's actions. None of these occurrences has been attributed to aircraft age, per se. Most have resulted from inadequate or improper inspection or maintenance. Others were attributed to inadequate design. However, some of these did involve relatively high time airplanes.

Is it possible that had the high time planes been subjected to more frequent inspections the fatigue cracks would have been detected?

We certainly hope so, but it is an open question. Why? The FAA program to ensure against this happening has not been fully implemented, nor is its coverage yet as broad as it might be.

The FAA's program to determine which components of the older turbojet airplanes designed under the fail-safe concept require more frequent inspection for fatigue is called the Supplemental Structural Inspection Program for large transport category airplanes. It is designed to adjust the frequency and method of inspections to assure continued airworthiness as airplane structures age. In essence, the program provides special attention to areas of the airplane not necessarily found to be of concern during the original structural analysis, as well as to areas which experience service difficulties -- all to ensure continued structural integrity.

Under the program, manufacturers develop Supplemental Structural Inspection Documents (SSID) which, among other things, identify and describe structurally significant items, the type of potential damage to be addressed, likely damage sites and the damage tolerance ratings of the structurally significant items. The documents recommend inspection methods, procedures and alternatives, inspection time thresholds and intervals. They also provide guidance to operators on how to perform the inspections. Thus, the inspection documents amount to a revised maintenance reliability program for the airplane.

The program has produced results. Through it, Boeing has identified significant structural items on the B-727, 737 and 747 that will require additional inspections as the airplanes age. Thus, the Supplemental Structural Inspection Program should provide protection against catastrophic loss of older planes from the fatigue failure of critical parts or components. However, not all commercial airplanes are under such a program.

To date, Boeing has developed Supplemental Structural Inspection Documents for the 707, 720, 727 and 747 models. McDonnell Douglas has completed a supplemental inspection document for the DC-8 which was approved by FAA last February 28. The company is scheduled to complete its document on the DC-9-30 this month; on the DC-9-10 by June 1987 and on the DC-9-40/50 and the DC-10 by June 1988.

Lockheed has a target of March 1987 to complete a supplemental inspection document for the L-1011.

Until all the inspection documents are complete, the continued airworthiness of these aging airplanes is being addressed through conventional service bulletins and airworthiness directives.

How about older, non-jet airplanes? Aging Convairs, Electras and the DC-3s probably undergo less stringent inspection programs than would have been required if specific supplemental inspection procedures had been developed for these airplanes.

The Board would feel more comfortable knowing that the added safety protection of the Supplemental Structural Inspection Program covered the entire commercial airplane fleet. Shouldn't that be the goal?

Let me raise another question about the Supplemental Structural Inspection Program. Can it adequately detect corrosion?

Boeing's supplemental inspection documents do not directly address the issue of corrosion, rather just fatigue cracking. Boeing holds that the more general problem of corrosion is properly handled through continuing maintenance of the airplane and not through the supplemental inspection program. FAA appears to agree. However, corrosion problems are treated indirectly in the supplemental programs in that most often corrosion in airplanes is reflected in fatigue cracks.

Should this be the case? I submit the answer is unclear. The Safety Board believes this requires monitoring to make sure that corrosion in older airplanes will be properly addressed.

Another question of special interest to us involves the use by Boeing of the "candidate airplane" concept for the supplemental inspection program. Under this concept, all Boeing airplanes with a specified number of flight cycles on a given date -- other than the 707/720 models -- were selected for supplemental inspections. Significant cracks identified through these inspections result in service bulletins and airworthiness directives by FAA which are applicable to all such airplanes.

Is the Boeing candidate fleet sufficiently large and inclusive? Can it accurately provide sufficient warning of the existence of previously undetected fatigue cracks so that fleet-wide inspections can be instituted before any failures occur?

The concept of using a sampling process to detect fatigue cracks and to determine the need for inspections is not new. However, we believe the jury is out on both questions, and a special eye on the situation is needed.

There is also a question or two about the program's ability to find problems before they become serious.

About five months ago, fuselage frame cracks which I mentioned earlier were discovered in the nose section of a B-747 that was undergoing modifications. Three consecutive forward fuselage frames were found severed over the nose wheel well area. In February, after an additional 12 airplanes had been found with cracks in the nose section, the FAA issued a telegraphic AD to require inspection of this area. As of March 31, 80 airplanes have been inspected for nose section cracks and half were found to have them. The longest was 3/4 of an inch. Fatigue cracks also were found in stringers and stringer clips. All of these planes are still capable of handling the ultimate loads for which they were designed, according to FAA.

The FAA views the occurrence as a continued airworthiness problem to be controlled by ongoing maintenance and to a lesser extent by the Supplemental Structural Inspection Program. It is important to note that the frames in

question had not yet been scheduled for inspection under the Supplemental Inspection Program. FAA engineers say that the cracks would ultimately have been detected by this program.

Although none had progressed to the point of safety being compromised, the manufacturer is developing long-term solutions which will probably involve material changes, heavier gauges of material or additional doubler plates. We understand that changes will be incorporated on production planes and offered to operators as a retrofit to existing airframes.

All of this tells me that we must be alert to any signs that the additional protection envisioned from the supplemental inspection program may not be sufficient.

Still another question: what about cracks originating in areas of the plane that are not accessible without removal of its skin? Structural failure resulting from fatigue cracks originating on unaccessible but structurally significant parts or components and from corrosion of such parts can cause catastrophic structural failure to a plane as surely as fatigue cracks of accessible parts under the supplemental program.

Now let me turn to the issue of aging airplane engines.

A formal program of supplemental inspection for engines has not been developed by the FAA. The continued airworthiness of engines is addressed

through maintenance reliability programs and the identification of problems in service, as well as the issuance of service bulletins by the manufacturers and airworthiness directives by the FAA.

For the most part, turbojet engines have brought a new level of reliability to aviation. However, despite a history of solid, safe performance, we are going through a period where the most widely-used of these engines in the commercial airplane fleet -- the Pratt and Whitney JT8D -- has been experiencing some maintenance problems which are causing difficulties for the carriers.

The history of the JT8D-1 through 17AR engine provides some insight into the current process and difficulties in maintaining aging engines.

The JT8D was designed in 1960 and certificated in 1963; production of the basic models of the engines 1 through 17AR was discontinued in 1985. Certain updated versions -- JT8D-200 models -- still are in production for the MD-80 series airplanes. There are about 12,000 engines in service on some 3,900 airplanes.

The engine teardown was increased gradually, based on operating experience, from 1,400 hours in July 1964 to 13,850 hours in June 1971. Eventually the requirement to teardown the engine in a specified time was eliminated and operators were permitted to teardown and inspect the separate modules at specified times or when their condition warranted inspection. Engine Condition Monitoring (ECM) now permits operators to overhaul only when the ECM program indicates the need for an overhaul.

Some airlines have elected this for their system of maintenance reliability. Others continue to perform so-called hot section inspections and certain heavy maintenance on a hard time basis.

What has been the difficulty with the JT8D?

Perhaps the most severe JT8D problem, in terms of potential serious harm to the airplane, is the failure of second stage turbine disks, which can result in uncontained engine failure. I should note here that turbojet airplanes are designed to fly with the loss of an engine; failures are expected to occur and redundancy is built in accordingly. However, uncontained failures can result in the release of engine parts which can cause serious structural damage to the plane. To date, there have been seven turbine disk failures. No warning is given in advance and these failures cannot be detected by an engine condition monitoring program.

In July 1985, after an accident involving a Saudi Arabian B-737, the Safety Board issued a recommendation that the FAA address this problem. The FAA subsequently did so in an Airworthiness Directive.

Another significant JT8D problem is the failure of high pressure compressor removable sleeve spacers. Spacer failures result from fatigue cracks. The only indication of a cracked spacer that might be detected by engine condition monitoring is high engine vibration.

As with turbine disk ruptures, engine parts which might be ejected are capable of causing airplane damage. This problem first occurred in the mid-1970s, and to date there have been 47 spacer failures, of which eight have penetrated the engine cowling.

On November 8, 1985 the Safety Board issued recommendations after the investigation of the fatal crash in Milwaukee of a DC-9 on September 6, 1985 revealed that a high pressure compressor removable sleeve spacer had ruptured.

The Safety Board recommended that the FAA require removal of all six spacers in the high pressure compressor. We said they should be replaced with integral sleeve spacers as soon as practical, but not later than the next time the engine was in a facility in which the maintenance could be done.

On January 2, 1986 the FAA proposed an Airworthiness Directive requiring inspection and replacement of certain removable spacers according to a specified schedule.

In commenting on the proposal, the Safety Board repeated that these spacers should be replaced as soon as practical, but no later than 4,000 cycles time-in-service from the effective date of the directive. We recently have recommended that inspections be performed every 1,000 cycles until the spacers are replaced. The FAA has as yet not agreed with our recommendation.

Another JT8D problem involves combustion chamber cracking, which also potentially exposes the airplane to damage. This results primarily from improper maintenance and inspection made worse by extended operating time and previous combustion chamber repairs. Failure of a combustion chamber figured into the crash of the B-737 at Manchester, England on August 22, 1985 which resulted in the death of 55 persons.

As a result, the FAA issued telegraphic Airworthiness Directives requiring inspection of those JT8Ds not operated under the Engine Condition Monitoring Program. On November 8, 1985 FAA published an NPRM proposing additional inspections of the combustion chambers, including those being operated under the ECM programs. The Safety Board agreed the action was urgently needed.

However, a later development led the Board to believe that the action was insufficient. This was an incident at LaGuardia Airport on February 6, 1986 involving a combustion chamber failure in a Boeing 727, which fortunately did not threaten the airplane. The circumstances of this incident suggests a deficiency in the ECM program under which the engine was maintained, and in the FAA surveillance of the carriers' use of the ECM Programs.

Accordingly, the Safety Board recently sent new recommendations to the FAA. We called on the agency to require inspection of high time combustion chambers as soon as possible and to review the adequacy of the Engine Condition Monitoring programs.

The Safety Board asked the FAA to develop minimum standards for these programs and to improve surveillance to justify them as a primary indicator of engine operating health.

Still another JT8D problem has been failures in combustion chamber outercases from fatigue cracks or other difficulties. Some 35 incidents of these are known. Such failures also can result in airplane damage. Some of the outercase failures result from fatigue cracks which originate either at the outercase rear flange or at the drain boss or pressure tap weldments. These failures have occurred only on engines with more than 25,000 operating hours. However, rupture of the combustion chambers permitting high temperature gases to impinge on the outercase has also caused outercase failure.

The Safety Board has registered concern with the FAA about these fatigue cracks. The FAA has issued a final rule but it addresses only the cracks originating at the outercase flanges. The Board is preparing new comments on the rule to say that not only are new and better inspections needed, but that fatigue cracks originating in outercasing locations should be addressed too.

The JT8D has still other problems. There have been failures of second-stage fan blades, failures of high and low pressure turbine blades and internal engine fires.

Because of the number and significance of these failures, the FAA has devoted considerable time and resources to develop and publish rulemakings

to address these problems, and has had difficulties in expeditiously developing and processing effective action. The air carriers are also experiencing problems in scheduling and implementing the numerous inspections, repairs and parts replacements imposed on them by the proliferation of service bulletins and ADs. The carriers contend that there is a lack of inspection equipment, overhaul facilities and replacement parts and that the logistics of scheduling the required actions provides serious difficulties for them.

The Safety Board is concerned that addressing each of these problems as they have arisen has resulted in a rather complex and unwieldy engine maintenance program which operators and repair facilities may find difficult to implement effectively.

As a result, the Board in its most recent recommendations asked the FAA to convene a maintenance review board comprised of experts from Pratt & Whitney and maintenance overhaul facilities to review the JT8D-1 through 17 AR engine maintenance program. The review would cover such areas as time limits on parts, inspection requirements, engine modifications and criteria for repair and replacement of aging components.

As I mentioned earlier, there are no special requirements to address the continued airworthiness of aging engines analogous to the Supplemental Structure Inspection Program for aging airplanes. Despite the safe performance of the JT8D in the past, it is necessary to look ahead to prevention of potential problems caused by aging.

The convening of a maintenance review board to review the programs under which aging engines are maintained could serve that purpose.

One sure way to reduce the failure frequency of aging engines and to assure the airworthiness of aging airplanes is to improve the effectiveness of the FAA's surveillance of the system in which both are operated and maintained.

We have advocated more and better FAA surveillance before in other forums, and we repeat that message here.

Proper inspection and maintenance is the key to continued airworthiness of aging airplanes and engines. Proper FAA surveillance of the implementation by airplane operators of their maintenance reliability programs is the key to the proper inspection and maintenance of the aging fleet.

Mr. Chairman, that concludes my formal statement. I would be pleased to respond to questions.

Mr. BROWN. Mr. Burnett, just for my information, could you give us, or give me some rather simple information? How frequently are engine and structural parts subjected to routine inspection? I assume there is a schedule that requires that to be done.

Mr. BURNETT. Well, it is different for different parts, and it is also different for different engines because the FAA regulates that according to the performance of the engine. For instance, the JT8D engine, which has been the subject of quite a few accident and incident investigations recently and is the one that is used in almost all of our narrow-bodied aircraft in this country, was originally subject to a teardown inspection every 1,300 to 1,400 hours, I believe. Dr. Loeb is free to correct me if I am mistaken about that. And it has now been extended up to 13,000. In fact, many operators have elected to go under an engine condition monitoring program that frees them from the ability to inspect, to do a teardown on a hard-time basis, and only have to do that when the ECM program indicates that there is a problem.

Dr. Loeb, would you want to expand on that?

Dr. LOEB. Yes. Insofar as engines are concerned, I think member Burnett has expressed exactly right. Now in the case of the JT8, there are very, very few hard-time items on that engine at this point, and there are no teardown requirements in terms of disassembly of the modules. But rather they are torn down on condition or as a result of an engine condition monitoring program.

Airframes, on the other hand, are subjected to a number of different types of inspections. They have A checks, B checks, C checks, and some of the parts are inspected quite frequently; others, obviously, on a longer term basis. Some might not get checked more than once every couple of years depending on—or even more, depending on the particular part.

Mr. BROWN. Thank you.

Mr. Lewis, do you have any questions at this point?

Mr. LEWIS. Just a couple, Mr. Chairman.

I guess I have sometimes a hard time determining who has the real responsibility of aircraft safety. I know we legislated that the FAA will perform inspections, but that certainly doesn't take the responsibility off the carrier. And I think sometimes one uses the other as a crutch and the blame goes back and forth.

I think it is interesting you mentioned the JT8D, and I believe it's about 15 percent of those engines have been upgraded to the engine that took care of the problem of the blades and vanes, the spacers moving out destroying the siding, canting the aircraft, and going into the fuselage, by putting a belly band around that section and spewing the stuff out the tail end of the engine.

This was developed, or rather, advanced, researched and approved in the summer of 1964, and since then only about 15 percent of the engines have been upgraded to that area. Whereas the responsibility there is that FAA has notified the airlines, the manufacturer has notified the airlines that this fix is in the engine, and the airlines do not comply. But we still have a serviceable area of time on an engine which increases the TBO, the 13,000 hours that you were mentioning, I believe. And so the history of the engine shows it has x number of hours without failures to allow the TBO to be raised.

Who has the responsibility here, Mr. Burnett, to protect the lives of these people in these aircraft when it's fully known that there's a fix on an engine, and also the time on the engine merits an increase in the TBO?

Mr. BURNETT. Well, I think it's a joint responsibility. Certainly the initial and primary responsibility is with the carrier that provides the service. However, I think we see an increasing responsibility on the part of the FAA in the deregulated environment where there is a temptation. Regardless of whether it's being experienced or a response is being made to it, there is a temptation in the deregulated environment to reduce costs by failing to provide the kind of maintenance that we would all want to see. And I think in that deregulated environment it's—we're going to have competition, price competition and route competition. It's important to see that everybody is playing by the same set of rules, and that's the responsibility of the FAA.

Dr. Loeb, would you have any comments on that?

Mr. LEWIS. Well, what would your feeling be if we just said that the FAA no longer had any responsibility to inspect these aircraft and that the airlines had to provide a safe aircraft for the consumers to fly in? What would be your reaction to that?

Mr. BURNETT. I'd probably take the train. [Laughter.]

Mr. LEWIS. Might not be a bad idea, because they need some help.

Mr. BURNETT. Well, it might be very good for that industry. But I would not be comfortable with an environment in which we did not have oversight by the FAA and we had—because I don't think the general consumer is able to determine the safety of the aircraft that they're boarding, and I think they have to have technical assistance to do that and I think that should come from the government.

Mr. LEWIS. OK. Then what is your recommendation? The FAA does have the responsibility. What is your recommendation, then, to get them up on the step to meet their responsibilities and make these airlines safe?

Mr. BURNETT. Well, we've made many recommendations to the FAA, both for improving its regulations in the area of the engine, engine maintenance area. We've made many in the last year, year and a half to the FAA. We've also made recommendations to them about improving the quality of their surveillance. Actually they're limited very much in doing—in their ability to do that because they do not have adequate personnel. There are steps ongoing to increase the number of inspectors they have. But the success of those steps is going to be dependent upon the availability of qualified personnel within the very constricted—competitive, I should say, labor market for technical personnel now in the airline industry. So that I think it's going to be very hard for them within the short range to provide enough people to have the kind of inspection program and surveillance program that I would like to see.

Mr. LEWIS. One final question, if I may, Mr. Chairman.

What would be your response to an airline that, if you had the responsibility such as FAA does, and say you have $78 million in fines coming to you because of unsafe practices but will settle for

$9½ million; and the airline says: Heck, no. We're not going to do that. We'll take you to court?

Mr. BURNETT. Well, I've, of course, followed that particular incident in the—instance in the paper like everyone else has, and one of the options the FAA had would have been to suspend the airline and then allow them to appeal that issue to the National Transportation Safety Board, and then we would have—it would have been in our lap.

I cannot comment on the validity of any one of the FAA charges. I am pleased to see that the FAA has embarked upon a more aggressive posture of surveillance of the—not only the smaller carriers and new entrants, but also the larger and more established carriers. And I think that will bear fruit in safety. But I am not in a position to comment upon any one of the—the validity of any of the charges or the total that's produced in terms of $1,000 per violation to get the total amount.

Mr. LEWIS. Well, my point is not so much the dollars, but the hiatus between the time of saying that you will correct the problems and then getting into possibly a lawsuit or negotiations back and forth on how the fines are paid. We're still flying with unsafe aircraft is what I'm saying.

Mr. BURNETT. Well, I think their position is that those problems have been corrected. Again, I'm not in a position to endorse that or not. I would hope that the FAA has seen that they are all corrected. But certainly I'm concerned about the fact that that number of violations was accumulated over a period of time in which the surveillance system was not adequate to detect them. So in order to get that kind of compilation of numbers of violations you had to have things ongoing for a long period of time in which I would have hoped that they would have been corrected. Detected and corrected.

Mr. LEWIS. Thank you, Mr. Chairman.

Mr. BROWN. Mr. Glickman.

Mr. GLICKMAN. Thank you, Mr. Chairman.

First of all, Mr. Burnett, I want to say for the record what a fine job you've done at the NTSB. And I do not know whether you are going to be reappointed as chairman, but it is my recommendation that you be reappointed as chairman. You've served this administration and the country very well in your independence and your impartiality.

Mr. BURNETT. I certainly hope to be reappointed.

Mr. GLICKMAN. Yes. At what point does an airplane become too old to fly? And is there a useful life for an airplane like there is for a building? Or, you know. I mean, after all we depreciate things based upon "useful life" under the tax laws. Is there a useful life for an airplane?

Mr. BURNETT. Well, I think an airplane is very much like a building. Many buildings go on forever. If we were across the ocean, we would find many of them there that still have a great deal of utility as buildings, even though they're not modern. Airplanes can go on also forever, if they're correctly and adequately inspected. And the value of many airplanes justifies that kind of effort. What we have to be sure is that those inspections are carried out, and that if—and when they are carried out, if problems

are detected, that they're judged according to very high standards, and that those who are doing the inspections are willing to put them on the ground, if there is anything that compromises safety.

Now we're faced with an environment in which we can't be as sure of that as we once could. Because we have competitive pressures and we have the lack, right now, in place of a system that can keep those competitive pressures, keep the airlines from responding to those competitive pressures. Now I'm not saying necessarily that's been done. In fact, I do want to say that the Safety Board has not had I think, as much concern about maintenance issues as has generally been expressed in the popular media. And I think in my own—in my case, more concern about operational issues than has been generally expressed.

So I'm not saying that I think that we have kind of deterioration in maintenance, across the board, that's often being expressed in popular fears at this time.

Mr. GLICKMAN. Well, I would make one point. I had breakfast with the Secretary of Transportation this morning, and I got the clear feeling from her, that she shares your views on the issues that you've talked about today, and I hope those can be implemented down through the FAA system itself.

But don't we, in fact, and particularly as it relates to the number of new and relatively inexperienced air carriers entering the market, operating older aircraft—does that present a problem to you? And No. 2, don't we have a lot of these air carriers contracting out maintenance and not doing it themselves?

Mr. BURNETT. I think that is all part of the problem that we're facing right now. We do have a lot of new entrants, some of which are well intended, but don't have the experience that perhaps, have been characteristic of our older established major carriers. We also—many of them, and it can go as large, to as large a carrier as People's Express, do a lot of their maintenance through contract relationships. And the question that that raises is, first, are the contractors as loyal to the products of the people that they—to the service and safety of the equipment that they service for another airline, as they are for their own; and, second, has the FAA adjusted to the necessity of properly surveilling that kind of relationship, or where you have the responsibility being with the PMI for the company that's contracting for the services, but yet you have to oversee the work of the company that's actually performing them.

So all of those complicate the surveillance process that we have to go through, and also the execution of the requirements by the individual airlines.

Mr. GLICKMAN. Going back to the useful life, I assume there are some parts of an airplane that have a useful life—a fuselage, a wing. I mean, there's got to be some things that become impractical to replace.

Dr. LOEB. There are, there are some parts of airplanes that do have a useful life, or a hard time, at which time they are replaced. That they are under the safe life, safe life limit, and a specified number of hours. Landing gear and other parts like that. But the majority of the components on an airplane do not have a useful life.

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As member Burnett indicated, the manufacturers generally specify an economic fatigue life, but that is for, generally for an economic purpose; and that is they know that their customer is not going to be willing to purchase an airplane, unless they are fairly sure that it is not going to suffer from major cracking or corrosion during a given period of time, or a number of cycles. But the airframe itself—the airplane as a whole, the airframe itself, and, indeed, major components of it do not have an economic—I mean, a safe life associated with it. Some few components do. Most of them are on an inspection program and so long as they are inspected and repaired they can go on forever.

Mr. GLICKMAN. Just one more question. We're going to have to stop for a moment because of—the committee is in. But let me just——

Mr. BROWN. I'm going to turn over the chair to Mr. Glickman, and we'll see how well he can handle it.

Mr. GLICKMAN [presiding]. For a short period of time.

The whole NASA incident with the *Challenger* clearly indicates that simple issues of management can be—lead to catastrophic operational problems. Do you see that we have any potentiality for catastrophic operational problems as a result of questions relating to who is in charge of maintenance, safety, of replacement of parts of airplanes, of, you know, all the kinds of issues today? I mean, do we know who basically is running the show? In fact, running the show; not who's supposed to be running the show?

Mr. BURNETT. As between the FAA and the carriers?

Mr. GLICKMAN. And the carriers; yes.

Mr. BURNETT. Well, I don't—certainly the safety board has been increasingly concerned about management issues, and as you know, we've addressed many of those.

Mr. GLICKMAN. Internal management within the carriers themselves.

Mr. BURNETT. Internal management issues, we've addressed many of those in the course of our accident investigations. We—of course, the FAA regulations almost organize the carriers. They require a vice president for maintenance, a vice president for operations, and all those things, which has made it relatively easy for the FAA to, under at least the regulated environment, for them to surveill. Because it was a very well-established, clearly understood relationship between gentlemen who worked with each other for long periods of time. And as we have new entrants who are organized in different ways and trying new things, you all of a sudden have situations where the traditional organization that you once relied on is no longer quite in place. And I think that's complicating things.

And I think also you have the change in management attitude. It's now a competitive attitude. And that's—we've got to be very careful that we do not assume that the ways of doing things in the aviation industry that have been established over the last 50 years are going to continue in this environment, and that requires, then, a more aggressive posture as far as the FAA is concerned. If you will, more adversarial. Although we don't want to see adversarial—a relationship for adversarial purposes, you certainly have to have an aggressive attitude there. And I think the FAA is responding to

that. The problem is that they have—changing attitudes is a slow process, and in order to get into that posture they have to have more people than they have. And they—both for budgetary reasons and the limitations of the available expertise, they're restricted in what they can do.

Mr. GLICKMAN. Well, just in closing, my meeting with the secretary this morning indicated to me that at least from her perspective having an adequate number of experienced people was the higher priority to her and that she was not going to let any arbitrary budget constraints interfere with air safety which she believes the public wants at whatever cost. I mean, if managed properly. And I take her at her word for that.

Mr. BURNETT. I do also on that. But I think it's going—she's still going to have a serious problem meeting those needs out of the market we have, as the safety board is having, I'll assure you, problems, and for the dollar that the government pays, getting top expertise in a competitive, very competitive market where the aviation industry is expanding.

Mr. GLICKMAN. Thank you very much. I think we're going to have to stop for just a moment, and we should be back. Recess until 10:45.

[Recess.]

Mr. LEWIS [presiding]. The Subcommittee on Transportation, Aviation and Materials will reconvene.

The chairman should be back shortly. We are, unfortunately, running back and forth between the main committee. We have votes over there on amendments on an appropriation and authorization bill.

So we are now going to hear from Mr. Anthony Broderick, Associate Administrator for Aviation Standards of the FAA.

Mr. Broderick.

STATEMENT OF ANTHONY BRODERICK, ASSOCIATE ADMINISTRATOR FOR AVIATION STANDARDS, FEDERAL AVIATION ADMINISTRATION

Mr. BRODERICK. Thank you, Mr. Chairman, members of the subcommittee. I welcome the opportunity to appear before the subcommittee today to discuss the subject of aging aircraft in the air carrier fleet. This is an important issue which warrants the continued interest of all within the aviation community.

The subject of aging aircraft in the Nation's air carrier fleet is one we have been concerned with and have aggressively been addressing for some time now in cooperation with both the manufacturers and the airlines. It is readily apparent that as the age of individual aircraft used in the fleet continues to increase the opportunities for corrosion or fatigue of critical components of those elements likewise increase. Therefore, the challenge which has faced us, along with manufacturers and operators, has been to develop design standards which reduce the likelihood of catastrophic failure, prescribe inspection intervals which will enable cracks or corrosion to be detected prior to the onset of failures of critical components, and monitor service history of aircraft not only as a means of improving our design standards and refining inspection intervals

but to permit the timely correction of potential problems by the issuance of regulatory airworthiness directives, or ADs. We have continued to improve upon our ability to achieve those important objectives.

In the early 1950's, the standards relied upon careful detail design to prevent the failure of key aircraft components by fatigue. Under this approach, we depended upon a maintenance program developed on the basis of previous transport service experience. Hard time inspection programs were used.

Before the advent of the jet age in the late 1950's, the FAA developed standards which permitted either a safe-life or a fail-safe approach to design fatigue. Under the safe-life approach, there was a required scheduled replacement of a part in accordance with the expected life of that part. The aircraft was simply retired from service when it became impractical to replace a part such as a wing or fuselage. Starting with the Boeing 707, the fail-safe approach was applied in the design of all U.S. commercial jets. Parts were constructed with a built-in redundancy under the premise that the aircraft could operate safetly with an undetected flaw until the next scheduled inspection could correct it. Under this philosophy, aircraft are designed so that the rate of crack propagation will not reach a critical stage prior to the next scheduled inspection or maintenance.

Manufacturers were called upon to recommend maintenance and inspection schedules, based on test data, at the time a new aircraft was introduced into service. Changes to the maintenance and inspection schedules could be approved for individual airlines if they could demonstrate that the changes to the maintenance program would also provide a comparable level of safety. In that respect, I would note that the fatigue life expectancy of a structure can only be finally determined after exposure to a variety of environmental conditions over many years of operation, so service history is a critical aspect of validating assumptions made during the design process and in assuring the continued airworthiness of an aircraft.

In 1978, the FAA introduced a newer design concept for newly certificated aircraft which is called "damage tolerance." A damage tolerant structure is one which has been designed to tolerate damage due to fatigue, corrosion, or accidental damage and continue to carry operational loads until detected either by the problem becoming evident such as a crack or during a scheduled inspection.

Scheduled inspections of such components are based on the fracture mechanics characteristics of the part, and are designed to detect any crack before it reaches unsafe proportions. In other words, under the damage tolerance approach we assume that damage will occur to a part from any of a number of possible conditions, including poor maintenance practices. That part must then be designed to safely accommodate that damage until it can be corrected. The safe-life approach could continue to be used for aircraft components on newly certificated aircraft to the extent that damage tolerance was not appropriate. One example where the safe-life approach is used, that is, a specific life is placed on the component, is in the landing gear.

We believe damage tolerance will provide important improvements in aircraft design for future aircraft, but it does not apply

directly to the vast majority of the aircraft in the current air carrier fleet because they were certificated prior to our adoption of the damage tolerance rule in 1978. Therefore, to address on a more current basis the need to assure that fatigue and corrosion were detected on aircraft in the fleet, the FAA issued guidance information to industry which outlines methods, which include fracture mechanics assessment, to assure safety of older airplanes through additional structural inspections.

The number and extent of these additional structural inspections are based on an engineering analysis that assumes the existence of a crack at all critical locations and determines its growth rate and the point at which it would become unsafe. This approach, which we finalized in concert with industry in 1981, is called the Supplemental Structural Inspection Documents program, or the SSID program.

Under SSID, manufacturers are asked to identify all structural components whose failure could affect safety of the aircraft, and to establish a special inspection program for these components. To date, SSID's have been developed for the 707, 727, 737, and 747. The FAA has taken regulatory action to require the airlines to adhere to the schedules called for in these SSID's. We expect to see SSID's developed for the DC-9-10, -30, -40, and -50, the DC-10, and the L-1011 within approximately the next 2 years, and would anticipate appropriate regulatory action to require compliance with their terms as well. The DC-8 and BAC-1-11 have SSID's which have not yet been established as mandatory by the FAA.

In terms of the issue of aging aircraft, I believe it is important to note that we are not experiencing a degradation of safety in commercial aviation, and that there is not cause for alarm. Clearly, the situation is one that merits attention and continued action on our part. Significantly, we have established an overall system in which all parties have an important role, and in which all parties must fulfill their functions responsibly and with the safety of the traveling public foremost in their minds.

The FAA, in addition to prescribing the appropriate regulatory framework and developing pertinent guidance material for use by industry, will continue to monitor the way in which all elements of this cooperative system are meeting their obligations.

The subcommittee also expressed interest in current airline maintenance practices, so I would like to briefly turn to that subject for a moment. I am aware that there has been much focus on this issue recently and that there is a general impression that airline maintenance practices have suffered as a result of an economically deregulated airline environment. I disagree with that assumption. What we have found is that the key requirement for a sound maintenance operation is not a company's financial success but rather whether there is a strong management focus on assuring the adequacy of the airline's maintenance system. This need for top level attention was evident before deregulation, and it remains so today. The challenge which faces us in the FAA is to conduct our surveillance in such a way as to identify those operators who do not insist on strict compliance with the FAA's safety regulations, and for us to continue to watch them closely, taking strong enforcement action when called for.

Our prior surveillance of airline maintenance practices simply was not adequate to meet this challenge either in terms of level or quality of effort. We reached this conclusion after comprehensive inspections of the industry, as well as critical self-examination of our own efforts. We have taken strong remedial action to address these deficiencies by increasing our inspector staffing and making a number of refinements in our surveillance program. For the first time, we now have in place national guidelines which prescribe minimum levels of inspection activities for each segment of the industry.

Further, we have instituted special indepth inspections of all operators on a cyclical basis. These inspections are conducted by teams that evaluate a carrier's activities in a level of detail which is simply not feasible in our routine surveillance. Not only will this enable us to better determine compliance with our safety regulations, but we expect that it will serve as an important deterrent to those who might otherwise seek to evade their safety responsibilities. Moreover, the national programs we have established provide for an overall surveillance program which is more balanced than before, assuring that adequate maintenance surveillance is exercised over all operators.

The importance of maintenance to aviation safety cannot be overstated. The vast majority of airlines recognize this fact. We intend to continue our current efforts to tailor our surveillance programs so that deficiencies are identified at an early stage and correct it. We believe that our present approach of greater headquarters' oversight of our surveillance activities, supplemented by an increased inspector work force, will demonstratively enhance the safety of our air transportation system.

That completes my prepared statement, Mr. Chairman, and I would be pleased to answer any questions the subcommittee may have.

Mr. BROWN. Thank you, Mr. Broderick.

With regard to this last point you made about being supplemented by an increased inspector work force, would you just outline very quickly what the status of the inspector work force is and in your plans for either enhancing it or maintaining it at some appropriate level?

Mr. BRODERICK. Very briefly, sir, we presented to the Secretary a plan for increasing the inspector work force and the support personnel that support their activities over fiscal years 1986, 1987, and 1988 by a total of 500 inspectors and support personnel. Through the appropriations in fiscal 1986, we have received congressional authorization and direction through the continuing resolution to put 60 percent of those, or 300, in place this fiscal year. We are on track to do that, and expect to completely meet the goal set by the conferees in fiscal 1986. That will be supplemented by the increase, I believe the number is 136 requested additional inspectors in fiscal 1987 and the remainder in future fiscal years. So we're on track, and despite the budget problems that we all know exist this is a top priority effort in the FAA, and I can assure you there is nothing that takes money away from the needed inspector work force enhancements. That includes, by the way, the necessary training that goes with hiring new people.

Mr. BROWN. You mentioned that you have a requirement for the replacement of landing gear at periodic times, that you have a life cycle on landing gear. Could you just explain that a little bit more to me? I assume that this is on the basis that the landing gear is subjected to the most intensive dynamic stress of any part of the aircraft and therefore requires particular attention as a result of that.

Mr. BRODERICK. Well, that's certainly right. It, obviously, for a short period in the beginning and the end of every flight is a very critical component. The actual reason for requiring, or for permitting a safe life is that it's very difficult to build. In fact, it's conceptually almost impossible to economically and practically build a redundant landing gear. You only have one element on each of the main gear that can carry the load, so there is no way that you can build redundancy into it. The kind of material that landing gear is made out of is material that is not subject to the kind of damage toughness that we have for other components in the airplane, so the most reasonable way that we have found to assure safety with landing gear is to require their removal after a demonstrated safe life and the replacement of the critical parts in it.

Those lives are set during the process of design and initial manufacture by the manufacturer, and reviewed and approved by the FAA prior to their establishment. We have had very good success with that program and would expect to continue to use that kind of approach for structure like landing gear.

Mr. BROWN. Do you identify—I'm sure you do, but just tell me about it—the number and type of accidents that can be attributed to landing gear failure?

Mr. BRODERICK. Yes, we do have. Actually, we use the NTSB data base. We have a common data base with them for accidents, and use all of their probable cause determinations and contributing factor determinations in the computer program. You can, in fact, look for that kind of information any time you want.

More importantly, whenever there is major damage done, and therefore major repairs made, we have a data base of our own which reports back through the system, from the airline through the FAA to the maintenance analysis center that we maintain in Oklahoma City, and from there to the original office that certified that particular part or aircraft. And the engineers that worked on that project review these reports of repairs or damage to see if it's the kind of repair that they anticipated and was built into the design or if something is happening that they hadn't anticipated that might require a mandatory corrective action by the FAA.

Mr. BROWN. Now with regard to other portions of the aircraft that are subject to some kinds of stress that results in an aging process or a fracture or development of cracks, and so on, this can be a fairly difficult thing to detect. Visual inspection sometimes is not adequate. Do you have recourse to things like x ray examination, and so forth, on critical aspects of an aircraft that are most likely to be subject to aging: development of brittleness factors, cracks?

Mr. BRODERICK. Absolutely. The industry uses and the FAA requires the use of appropriate nondestructive testing types of techniques when they're necessary. Let's use just one simple example.

Very often for reasons of stress concentration a small crack in a hole in which a fastener sits is very critical. If, in fact, that occurs there are two ways to look for the crack, or actually three. One, you can wait until it grows outside of the fastener head, which is not necessarily a good thing to do at times. The second is to take the fastener out, which may cause damage when you put the fastener back in, and that's an imperfect process. The third is to develop a nondestructive testing technique with a special probe—using an electricial current, for example—to try and find out if there is or is not a crack without doing any disruption to the actual surface.

So from time to time to examine the inside of fuel tanks, which is really the wing in an airplane, you use x ray techniques. We use ultrasonic techniques, anything that is available and, most important, proven to be effective in detecting exactly what it is you're looking for we will use.

Mr. BROWN. Just one additional question. I'm not sure that this is germane, but as long as we're looking at geriatric aircraft, do you have any way of correlating aircraft safety and accidents with geriatric pilots to determine if there is any possibility that there is an aging factor in the pilots that may relate to airline safety?

I know this has been somewhat controversial at times—

Mr. BRODERICK. Yes.

Mr. BROWN. when you've talked of regulating mandatory retirement ages, and so forth.

Mr. BRODERICK. We have an age 60 retirement rule for the reasons that you stated. We do have a data base of general aviation accidents, which, of course, is much larger than the data base of air carrier accidents. That data base has been analyzed and has indicated that after—and you can't be exact in here, but after approximately the late 50's or the age of 60 there appears to be an increase in the number, or rate, not number, of accidents for pilots. We have, in fact, presented that data in congressional testimony. I wish I knew why. We continue to monitor medical research in all relevant fields and to work with people like NASA and human factor experts on those kinds of programs.

That's a very difficult question to answer. In many ways the complexities of aircraft structure pale in comparison to the complexities of that kind of a question.

Mr. BROWN. Mr. Lewis?

Mr. LEWIS. Thank you, Mr. Chairman.

I would like to ask you what your procedure is, Mr. Broderick, or FAA's procedure, when you change a landing gear, then of course the wing spars, which take the initial jolt of the landing and certainly bend in the opposite direction that they normally are designed for, what kind of inspection do we have for those?

Mr. BRODERICK. When we originally accept the design proposal, if you will, for type certification for an aircraft, along with the design proposal in accordance with a logic that's been developed by industry and Government and accepted by the FAA—it's now called the Maintenance Study Group No. 3, I believe—there is a very sophisticated analysis of the loads distribution for each airplane during each flight and the kinds of redundancy that are built into the system to examine the frequency of inspection and the anticipated

cracking that will develop with each aircraft. So actually, it's probably a hundred percent true to say that well before a landing gear is replaced inspection of critical load-bearing elements like you mentioned but which are redundant, where the landing gear is not, have already taken place. They take place, virtually every part of an aircraft is examined and inspected at many times during the fleet life on a very carefully controlled and laid out program.

Mr. LEWIS. OK. You have a life cycle of a critical part in an aircraft and you also have a half-life. You know what the half-life of that unit is. When do you start your inspection for cracks, say, on a wing spar or on a bulkhead, or something like that?

Mr. BRODERICK. Well, a typical answer to that is that you would inspect for cracks, assuming we're using damage tolerance kinds of technology which is presently available——

Mr. LEWIS. Well, I'm referring to like the 747 problem.

Mr. BRODERICK. Right. If we look at a problem that we want to examine for cracking, we inspect before a redundant inspection would lead you to—I'm sorry; we inspect with enough time so that if you miss it on the first inspection you will have a second opportunity to catch the inspection before the crack becomes critical in length. So it really is not so much set on a safe-life part. You have a particular lifetime during which you inspect for any cracking at all but assuming you have found nothing, you just replace the part.

On a fail-safe part or a damage tolerant part, you have inspection intervals which are set on the rate at which the crack grows, so that—and what you do is assume typically that you will miss it on the first—miss the crack on the first inspection and that it should have been detected on that. So you allow ample opportunity for the crack to continue growing at the rate that you have calculated based on flight loads and validated with flight tests. So that you can catch it again on the second inspection before you, in fact, have a critical situation.

Mr. LEWIS. I see. In your testimony you made mention that you disagreed with deregulation causing a laxity of inspections. However, it's common knowledge, and has been printed in not only periodicals but most of the newspapers as well since the aircraft safety question has come to light over the past couple of years, that they have been using rapid turnaround and going to intermittent-type inspection, your traveling inspections, or what have you, where they're not grounding the aircraft for any period of time to go through a full inspection; and they're picking it up at various stations overnight, or something of that nature. Do you have inspectors to meet that criteria?

Mr. BRODERICK. Well, in fact, we do. We're very carefully watching the kind of thing that you talk about. The message I intended to convey was that deregulation doesn't cause problems in maintenance. It may, in fact, in the environment of increased opportunity for competition provide the opportunity to neglect maintenance. But things like the hub and spoke system, for example, doesn't cause a maintenance problem; it requires you to adjust the maintenance program to properly deal with it. But many airlines have done that. What our job is, as I see it, is to make sure that not many airlines do it, but that every airline does it; and if they don't,

we take aggressive corrective action and make sure that that deficiency is corrected.

Mr. LEWIS. During the past 18 months the FAA has issued more severe fines against a number of airlines for various safety violations. Does this indicate a decline in safety levels or does it indicate a change in the policy of the FAA? Why haven't these fines been leveled before?

Mr. BRODERICK. I think the latter, Mr. Lewis. I believe that what you see is the result of an evaluation that was actually started by the Secretary in a thing called the white glove inspection of all air carriers back in February 1984. When the administrator came onboard in I believe it was April 1984, he aggressively followed a program of vigorous enforcement of the regulations. We have a very clear and unwavering tough but fair enforcement policy that the FAA has followed consistently for the last 2 years. That resulted from a review of the situation that had arisen and a dissatisfaction with the then current situation several years ago.

Mr. LEWIS. OK. I want to get back to the JT8D again. The NTSB has expressed its concern that recent FAA actions with regard to the proliferation of AD's and service bulletins for the JT8D engine has resulted in a rather complex and unwieldy engine maintenance program, and that the repair facilities are finding it difficult to implement effectively. How would you respond to that? Then I have a followup on that.

Mr. BRODERICK. I would say that it is a complex program. There are a number of things that have come together at a point in the JT8D's mature lifetime which have caused some major inspections. Two AD's alone that we issued earlier this year were predicted to result in expenditures of over $100 million, so that's a lot of repairs that weren't planned let's say a year ago. There is a lot of complexity there, but I don't think it's anything like a complexity which can't be dealt with by the industry today. These are well understood situations. They are well understood fixes. The schedules that we have set are schedules which are aggressive but are within the parts capability and the labor supply capability that exists out there today. So I don't see any cause for concern that the program won't be effectively carried out, and we think it's necessary to carry out the program to maintain safety in the fleet.

Mr. LEWIS. Has there been any correlation between the time, the total number of hours flown with that particular engine and the three failures that we had which were similar, that caused some fatalities, as incipient failures, or were they determined to be—or could they have been avoided by going to the 1964 fix that had been recommended and which the FAA approved for that engine?

Mr. BRODERICK. The service bulletin that you spoke of earlier, I guess, with—I don't know that—in fact, I do know that we do not yet have a probable cause determination on what caused the Milwaukee accident. It is not—it is therefore not technically clear whether or not some kind of foreign object damage to another part of the airplane resulted from an uncontained engine failure. We know the failure was uncontained, but with the experience that we've had with spacer failures in similar incidents over the previous 20 years of the JT8D's life, that kind of failure has been benign from the viewpoint of energy release.

The parts are uncontained it is true. They do penetrate the engine case, but there is not a lot of energy which would result in collateral damage to either control systems or the engine. As a result, it is not at all clear that that kind of containment ring that you spoke of would have prevented the accident. I think we'll have to wait and see what the Board comes up with in its analysis of that before we could answer a question like that, sir.

Mr. LEWIS. When do you think you'll have that report?

Mr. BRODERICK. I would expect in the coming months, though I don't have a specific schedule from the Board.

Mr. LEWIS. Coming month?

Mr. BRODERICK. Months.

Mr. LEWIS. Months?

Mr. BRODERICK. This summer. Yes.

Mr. LEWIS. Is that 12 months; 14 months?

Mr. BRODERICK. Oh, no. A few months I would think. In fact, the complexity of the accident analysis and technical analysis that has gone on since that has actually caused somewhat of a delay. I know that they and we would like to have it sooner, but it's the technical work that's holding the report up.

Mr. LEWIS. Through the concern of that accident, and even before that report comes out, have you looked at other engines with a possiblity of not being able to contain their parts and also doing structural damage to the aircraft at any time; takeoff, in particular?

Mr. BRODERICK. Oh, yes. As you know, the takeoff is the most critical time because it's the time when the engine has the highest potential energy and available energy to do that kind of damage. There is a requirement that in the design of aircraft engine installations that the design be thoroughly reviewed to minimize all reasonable uncontained failure modes of the—or damage from all reasonable uncontained failure modes of the engine. As you know——

Mr. LEWIS. I just wanted to know if FAA has——

Mr. BRODERICK. Oh, yes.

Mr. LEWIS [continuing]. Reemphasized its inspections and taken a look at all the engines in use of various manufacturers and various types.

Mr. BRODERICK. It's a continuing thing. The one thing that you may have heard about recently is our redesign, or requiring Pratt & Whitney to redesign a repair of a disk which is a very serious problem, or had been a very serious problem which is now corrected.

There are no outstanding problems that I know of on any engines that would result in uncontained failures that would cause a lot of damage which we haven't addressed and corrected.

Mr. LEWIS. Would it be prudent for the FAA to tell the public that?

Mr. BRODERICK. I guess we don't do as good a job as I'd like to have us do in some of our public affairs.

Mr. LEWIS. Because the only thing they know of is that an engine blew up in Milwaukee on a DC–9 and killed some people, and everybody is afraid to fly on a DC–9 now. Not everybody, but the majority of people I talk to.

Mr. BRODERICK. Well, I certainly—that certainly is not a reasonable fear. It's not technically well-founded. I'll talk with our public affairs people and see if there's a way we can get the word out.

Mr. LEWIS. Well, I just raise that because I think we always show the down or the negative side.

Mr. BRODERICK. You're right.

Mr. LEWIS. And too often we don't, you know, when we look at the number of aircraft accidents and the number of planes flying in a day, it's unbelievable, the high safety record we have.

Mr. BRODERICK. Every 5 seconds nothing happens, and that's success. And it's kind of difficult to get excited about nothing happening I think, and that's really our problem. You're familiar with it. You've worked in the industry, I know. It's a tough thing to get manufacturers and operators and the Government to talk about because frequently people want to stay away from talking about the awful possibility of a catastrophe.

Mr. LEWIS. Thank you, Mr. Chairman.

Mr. GLICKMAN [presiding]. Thank you.

Mr. Broderick, a few weeks ago the General Accounting Office reported that the FAA has not responded effectively to the changes deregulation brought to the airline industry, and at present cannot say with assurance that airlines are complying with safety regulations. While you've spoken to some of this before, I wonder what is your specific response to the GAO's allegation?

Mr. BRODERICK. The GAO is wrong. The Administrator forcefully rebutted that testimony a week following it in the same congressional subcommittee—the Aviation Subcommittee—pointing out the aggressive programs that he and the Secretary have instituted to ensure that the traveling public gets the kind of safety it demands and deserves in air transportation. As Mr. Lewis said, the safety record of air transportation is something which is just unbelievable. The kind of success we have had in implementing programs in aviation safety, when you look at things like commuter accident rates that have just plummeted over the last 8 or 9 years, when you look at the kind of steady progress we're making in the air transport—scheduled air transport safety, and even in general aviation safety where it's still going down after years and years of continued decreases in accident rates.

I think our difficulty is one of communicating effectively with the public, and perhaps with the GAO. But we have an excellent, superb safety program in aviation in the United Sates and it's the envy of every other country in the world.

Mr. GLICKMAN. Well, I hope you're right, and I'm pleased that you feel so positive about it. Others have indicated over a period of years—those others being the GAO, Mr. Burnett, the NTSB—there are some deficiences in there, and hopefully you are in the process of correcting those deficiencies. Because it's interesting, as I go home and talk to my constituents, they don't mind cutting Government spending on some programs; but when you talk to them about air safety, they just about lynch you when you suggest that we need to reduce the number of inspectors and reduce the number of controllers and mitigate the ability of the U.S. Government to protect people who fly in airplanes. And I hope that you're cognizant of the fact that the public—not only does Congress, but the

public expects you to have basically a—have a perfect safety record in this country. Not a good one, a perfect one.

Mr. BRODERICK. I'm aware of that, sir. We are actually delighted to get the cooperation and work very closely with the GAO and the NTSB staffs on a daily basis. We recognize that there are improvements that we can make in our system, in the FAA's system. And it is the continual recognition and adoption of those improvements which has made the system as good as it is. And it's going to be better tomorrow than it was yesterday.

Mr. GLICKMAN. Now what is the current number of FAA maintenance inspectors, and how does that compare with the number in 1978?

Mr. BRODERICK. Current authorized number of FAA——

Mr. GLICKMAN. No. How many do you have now working for you?

Mr. BRODERICK. Let me provide you a number for the record. Let me tell you what I've got, air carrier and general aviation people, onboard as of May 5.

Mr. GLICKMAN. OK.

Mr. BRODERICK. It was a total of 1,521. I don't happen to have the onboard number broken out by maintenance and operations, but it's approximately one-half that. We will have that number certainly by the end of this year, I won't hold to it right this minute, but by the end of this year we'll have more maintenance inspectors working for the FAA, and I'm quite confident that is true as of today, than we have ever had before. And they're going up; there'll be more next year, too.

Mr. GLICKMAN. So right now would you say we're at about the levels we were in 1978?

Mr. BRODERICK. Higher.

Mr. GLICKMAN. We are higher now?

Mr. BRODERICK. Yes. With onboard people, yes.

Mr. GLICKMAN. And it's your intention to continue going higher than that?

Mr. BRODERICK. Yes, sir. In accordance with the program I described earlier, which will add a total of 500 inspectors and support personnel over 3 fiscal years, roughly.

Mr. GLICKMAN. Getting to the general aviation question, has the FAA ever considered at some point of the operation of a smaller airplane that does not transport passengers for commercial purposes, sunsetting the certification of that airplane?

Mr. BRODERICK. We have considered it. We always consider that. We've done it, in fact, both for large and small aircraft. But we don't see a need to, when we have continuing maintenance programs which provide for the safety of aircraft. If I'm not mistaken, there's an aircraft called the Huaco UPF–7 that was built in the mid-1930's that has never had an airworthiness directive issued against it. That's quite a testament to the design of that airplane. There's no reason that DC–3's that were built 50 years ago and are still operating today need to be retired because they're old. If you don't maintain them; if you don't inspect for corrosion, which is really the thing that'll get you with long times; and if you don't inspect for fatigue, which is something that will get you with high

utilization; then you'll have a problem. But pure age is not necessarily a problem, as Mr. Burnett indicated.

Mr. GLICKMAN. OK. But when you're dealing even with a DC-3 or a 747 or a DC-9 that, as a general proposition, the way it's flown and operated and maintained and inspected is different than when you're dealing with, let's say, a Beech Bonanza that may have been built 40 years ago, that has gone through 14 different owners, and that the inspection requirements and processes are different, and it is not flown to transport people. In that case the inspection and operation is a lot different, and the FAA is not out inspecting hundreds and thousands of small airplanes flying that were built 40 and 50 years ago.

Mr. BRODERICK. We just completed a thing called the general aviation safety audit where, in fact, we did tens of thousands of inspections on repair stations, individual aircraft, and schools and organizations that operated these aircraft. I would certainly agree with you, Mr. Glickman, that inspections are different for smaller aircraft and they're different for private aircraft. But different doesn't mean necessarily that the safety level is worse.

The kinds of service bulletins, the kinds of service experience, the kinds of techniques, like nondestructive testing that we talked about and use for large aircraft are applied in small aircraft where appropriate. The difference is not really in something that says that because it's done differently, it's therefore less safe. I think we try and tailor the programs to make the safety roughly comparable.

Mr. GLICKMAN. Well, you know, I've been very involved in the product liability issue. I have a bill that tries to deal with some tort reform, but as it affects general aviation, because it is a different issue than campers or boats or lawnmowers. And one of the things that we're faced with there is the fact that we have airplanes manufactured today that have to carry insurance on planes that were manufactured 30 and 40 years ago that may not be properly maintained. In fact, many of which are probably not even the subject of your general aviation audit. And that those planes are still flying in the skies and every time something happens with one of these old airplanes that have been modified, many without FAA approval, in accordance with techniques not approved by the manufacturer; then that manufacturer is liable for enormous judgments resulting from those kinds of activities because they happen to be the only deep pocket around.

Now I'm not asking you to comment on the tort reform aspect of the picture, but it does strike me that we may have a different ball of wax as it affects inspection and maintenance as they relate to older general aviation airplanes that are not in the business of carrying passengers for hire than we do with modern commercial airplanes.

Mr. BRODERICK. Of course many of those aircraft are in the business, or are utilized in the business of carrying passengers for hire. There are many, many Cessna 172's, for example, that are used in air taxis throughout the country. There are 4,000 air taxi airlines, most of which use small aircraft like that.

I would certainly agree that there are differences. I guess I would have a hard time figuring out criteria whereby age alone

would be cause for sunset, if you will, of a certification. The kinds of problems that you mentioned with flaunting of the regulations, illegal modification, improper maintenance, and that kind of thing is something that I think is not necessarily related to age and, unfortunately, also can cause serious accident in brandnew airplanes. And it has happened before and it will happen again. I don't necessarily see any direct and absolute relationship between age and——

Mr. GLICKMAN. From a parochial perspective, I'm seeing almost the death of an industry go right before my face, largely because of this product liability issue that is directly related to very old airplanes flying out there that are creating extremely big judgments. And I don't know what to do about it, and I just maybe was looking at a way through the back door to try to deal with this issue. It's something for you to think about.

One final question. It has to do with contract maintenance. We have a lot of big carriers now that are doing contract maintenance. I don't know if People Express still does contract maintenance—I believe they do. What is your relationship with contract maintenance, and what's the nature of your relationship with the maintenance company and the carrier on maintenance, as opposed to with the carrier that does their own maintenance?

Mr. BRODERICK. As a result of the program the Secretary initiated that I mentioned earlier, the white glove inspection, we found that contract maintenance had grown beyond our expectations in the middle of the first half of this decade, around 1983–84. We, as a result, instituted a series of maintenance seminars which familiarized all of our people with the kinds of things that you are talking about and the actions they needed to take, and the corrective actions that they needed to take to solve problems.

Briefly stated, an airline—People Express, to use an example—is specifically responsible for the maintenance of its aircraft and the safe conduct of its operation. If they do subcontract maintenance, if they contract maintenance out to someone else, they cannot contract out or pass on the responsibility. Responsibility remains with the carrier.

I might point out that much of their maintenance at a place like People Express is done under contract with other large airlines, like United Airlines; so I would hardly question the quality of that kind of work. As a matter of fact, there are good financial and business reasons for them wanting to select contract maintenance with other large carriers or large and very well-equipped repair stations. We have found that the question is not necessarily with the quality of work, but whether or not they understand, on the part of the person doing the contracting, that the airline that wants maintenance done is responsible for it. The maintenance inspectors at the FAA must ensure that that airline's maintenance program includes appropriate consideration of the contract arrangements that have been made. You cannot pass off to someone else your responsibility for safe operation of an airplane.

Mr. GLICKMAN. Thank you, Mr. Chairman.

Mr. BROWN. Mr. Broderick, just one final point. You responded very positively and seemed quite clear in response to Mr. Glickman's question about the GAO's criticism with regard to effective

deregulation on safety. And obviously, the GAO is not perfect in their criticisms, but I think we all need to be reminded that over the years the GAO made a number of critical reports with regard to NASA and their quality control procedures and other aspects of their operations, which NASA responded to equally positively as not being justified or that corrective action had been taken.

Now when something like the shuttle accident happens, of course, we go back and look at all these critical reports and whether or not they did have merit or that were adequately responded to, and the commercial airline industry has a lot more fatalities per year than NASA has. And it would be unfortunate if something were to happen which would cause us to come back and look at these GAO criticisms and find that maybe there were some merit to them.

In the case of NASA, NASA is going to go through a rather traumatic restructuring in procedures, and even personnel, as a result of this. And a lot of management changes. And this would happen in any situation, including with the FAA, if some critical accident develops that focuses congressional and public attention on it.

So we're always, I think, wise to not be too dogmatic in asserting our position, at least, without examining very, very closely as to the merits of it. And I just raise that as a caution to the FAA. We don't want you to have to undergo a traumatic experience like that. And we, to be honest with you, feel that maybe Congress has some responsibility in connection with NASA; that we didn't focus enough on these. And our efforts here are at least in part an effort to avoid complacency, you might say. And we hope you'll avoid complacency in connection with these things.

I'm not asserting that you are complacent. I'm just saying I hope you don't become complacent, even if you're not now.

Mr. BRODERICK. I couldn't agree more with what you've said. What I was trying to respond to was a specific point that Mr. Glickman raised that GAO raised, which was that the FAA could not assure the traveling public that the airlines are operating safely today. And I would most vigorously deny that assumption, or that statement.

I will say that, as I tried to indicate earlier, we work very closely with the GAO and welcome their participation in the studies that we initiated starting a couple of years ago that are self-examining, self-critical studies which are rebuilding our entire inspection and surveillance infrastructure within the FAA. We have benefited very greatfully from the contributions of GAO and their staff, and I certainly wouldn't want to leave the impression that I don't think that any of their criticism is wrong. In fact, much of it is right. Unfortunately, in that particular situation there was a lot of attention paid by the media to a few statements which were, perhaps, statements that I would disagree with in general.

[The prepared statement of Mr. Broderick follows:]

STATEMENT OF ANTHONY J. BRODERICK, ASSOCIATE ADMINISTRATOR FOR AVIATION STANDARDS, BEFORE THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON TRANSPORTATION, AVIATION, AND MATERIALS, CONCERNING AGING AIRCRAFT. JUNE 4, 1986.

Mr. Chairman and Members of the Subcommittee:

I welcome the opportunity to appear before the Subcommittee today to discuss the subject of aging aircraft in the air carrier fleet. This is an important issue which warrants the continued interest of all within the aviation community.

The subject of aging aircraft in the Nation's air carrier fleet is one we have been concerned with and have aggressively been addressing for some time now in cooperation with both manufacturers and the airlines. It is readily apparent that, as the age of individual aircraft used in the fleet continues to increase, the opportunities for corrosion or fatigue of critical components of those aircraft likewise increase. Therefore, the challenge which has faced us, along with manufacturers and operators, has been to develop design standards which reduce the likelihood of catastrophic failure, prescribe inspection intervals which will enable cracks or corrosion to be detected prior to the onset of failures of critical components, and monitor service history of aircraft not only as a means of improving our design

standards and refining inspection intervals but to permit the timely correction of potential problems by the issuance of regulatory airworthiness directives (AD's). We have continued to improve upon our ability to achieve these important objectives.

In the early 1950's, the standards relied upon careful detail design to prevent the failure of key aircraft components by fatigue. Under this approach, we depended upon a maintenance program developed on the basis of previous transport service experience. "Hard time" inspection programs were used.

Before the advent of the jet age in the late 1950's, the FAA developed standards which permitted either a "safe-life" or a "fail safe" approach to design for fatigue. Under the safe-life approach, there was a required scheduled replacement of a part in accordance with the expected life of the part. The aircraft was simply retired from service when it became impractical to replace a part such as a wing or fuselage. Starting with the B-707, the fail safe approach was applied in the design of all U.S. commercial jets. Parts were constructed with a built-in redundancy under the premise that the aircraft could operate safely with an undetected flaw until the next scheduled inspection could correct it. Under this philosophy, aircraft are designed so that the rate of crack propagation will not reach a critical stage prior to the next scheduled inspection or maintenance.

Manufacturers were called upon to recommend maintenance/inspection schedules, based on test data, at the time a new aircraft was introduced into service. Changes to the maintenance/inspection schedules could be approved for individual airlines if they could demonstrate that the changes to the maintenance program would also provide a comparable level of safety. In that respect, I would note that the fatigue life expectancy of a structure can only be finally determined after exposure to a variety of environmental conditions over many years of operation, so service history is a critical aspect of validating assumptions made during the design process and in assuring the continued airworthiness of an aircraft.

In 1978, the FAA introduced a newer design concept for newly certificated aircraft which is called "damage tolerance." A damage tolerant structure is one which has been designed to tolerate damage due to fatigue, corrosion, or accidental damage and continue to carry expected operational loads until detected either by the problem becoming evident such as a crack or during a scheduled inspection. Scheduled inspections of such components are based on the fracture mechanics characteristics of the part, and are designed to detect any crack before it reaches unsafe proportions. In other words, under the damage tolerance approach, we assume that damage will occur to a part from any of a number of possible conditions, including poor maintenance practices. That part must then be designed to safely accommodate that damage,

until it can be corrected. The safe life approach could continue to be used for aircraft components on newly certificated aircraft to the extent that damage tolerance was not appropriate. One example where the safe life approach is used (i.e., a specific life use is placed on the component) is for landing gear.

We believe damage tolerance will provide improvements in aircraft design for future aircraft, but it does not apply directly to the vast majority of the aircraft in the current air carrier fleet because they were certificated prior to our adoption of the damage tolerance rule in 1978. Therefore, to address on a more current basis the need to assure that fatigue and corrosion were detected on aircraft in the fleet, the FAA issued guidance information to industry which outlines methods (including fracture mechanics assessment) to assure safety of older airplanes through additional structural inspections.

The number and extent of these additional structural inspections are based on an engineering analysis that assumes the existence of a crack at all critical locations and determines its growth rate and the point at which it would become unsafe. This approach, which we finalized in concert with industry in 1981, is called the "Supplemental Structural Inspection Documents" (SSID) program. Under SSID, manufacturers are asked to identify all structural components whose failure could affect the safety of the aircraft,

and to establish a special inspection program for these components. To date, SSID's have been developed for the B-707, 727, 737, and 747. The FAA has taken regulatory action to require the airlines to adhere to the schedules called for in these SSID's. We expect to see SSID's developed for the DC-9-10, 9-30, 9-40, 9-50, the DC-10, and the L1011 within approximately the next two years, and would anticipate appropriate regulatory action to require compliance with their terms as well. The DC-8 and BAC 1-11 have SSID's, which have not yet been established as mandatory by the FAA.

In terms of the issue of aging aircraft, I believe it is important to note that we are not experiencing a degradation of safety in commercial aviation, and that there is not cause for alarm. Clearly, the situation is one that merits attention and continued action on our parts. Significantly, we have established an overall system in which all parties have an important role, and in which all parties must fulfill their functions responsibly and with the safety of the travelling public foremost in their minds. The FAA, in addition to prescribing the appropriate regulatory framework and developing pertinent guidance material for use by industry, will continue to monitor the way in which all elements of this cooperative system are meeting their obligations.

The Subcommittee also expressed interest in current airline maintenance practices, so I would like to briefly turn to that subject for a moment. I am aware that there has been much focus on this issue recently, and that there is a general impression that airline maintenance practices have suffered as the result of an economically deregulated airline environment. I disagree with that assumption. What we have found is that the key requirement for a sound maintenance operation is not a company's financial success but rather whether there is a strong management focus on assuring the adequacy of the airline's maintenance system. This need for top level attention was evident before deregulation, and remains so today. The challenge which faces us in the FAA is to conduct our surveillance in such a way as to identify those operators who do not insist on strict compliance with the FAA's safety regulations, and for us to continue to watch them closely, taking strong enforcement action when called for.

Our prior surveillance of airline maintenance practices simply was not adequate to meet this challenge, either in terms of level or quality of effort. We reached this conclusion after comprehensive inspections of the industry, as well as critical self-examination of our own efforts. We have taken strong remedial action to address these deficiencies by increasing our inspector staffing and making a number of refinements in our surveillance program. For the first time, we now have in place national guidelines which

prescribe minimum levels of inspection activity for each segment of the industry. Further, we have instituted special in-depth inspections of all operators on a cyclical basis. These inspections are conducted by teams that evaluate a carrier's activities in a level of detail which is simply not feasible in our routine surveillance. Not only will this enable us to better determine compliance with our safety regulations, but we expect that it will serve as a important deterrent to those who might otherwise seek to evade their safety responsibilities. Moreover, the national programs we have established provide for an overall surveillance program which is more balanced than before, assuring that adequate maintenance surveillance is exercised over all operators.

The importance of maintenance to aviation safety cannot be overstated. The vast majority of airlines recognize this fact. We intend to continue our current efforts to tailor our surveillance programs so that deficiencies are identified at an early stage and corrected. We believe that our present approach of greater headquarters' oversight of our surveillance activities, supplemented by an increased inspector workforce, will demonstratively enhance the safety of our air transportation system.

That completes my prepared statement, Mr. Chairman. I would be pleased to respond to questions you may have at this time.

Mr. BROWN. Well, we appreciate your testimony very much. Thank you for it, and we'll continue to be in touch with you on this.

Mr. BRODERICK. Thank you.

Mr. BROWN. Our next witness is Mr. Benjamin Cosgrove, vice president for engineering of Boeing Commercial Airplane Co.

Is that really the name of your company, Boeing Commercial Airplane Co.?

Mr. COSGROVE. It's the Boeing Corp. But we're a company inside a corporation; yes, it's the Boeing Commercial Airplane Co.

Mr. BROWN. You may proceed with your statement, Mr. Cosgrove; and if you wish to summarize any portion of it, the full text will be in the record.

STATEMENT OF BENJAMIN COSGROVE, VICE PRESIDENT—ENGINEERING, BOEING COMMERCIAL AIRPLANE CO., SEATTLE, WA

Mr. COSGROVE. Mr. Chairman, and honorable members of the Subcommittee on Transportation, Aviation and Materials, I would like to thank you for the opportunity to speak with you about the safety of aging commercial aircraft. I'm, as said, vice president of engineering of the Boeing Commercial Airplane Co. And I am not going to read the prepared statement but will summarize some of them.

We at the Boeing Co. fully recognize our responsibility to support the air transportation system of the United Sates and the world with airplanes that can be operated safely as long as they can be made serviceable. The 1968 FAA-industry committee on older pressurized aircraft, it was concurred that the manufacturer, the airline, the FAA are all critical partners in keeping aircraft safe. Boeing has always felt that the manufacturer of the aircraft has the knowledge from tests, analysis and previous fleet experience where to look for structural damage, and competent inspections by the airlines regulated by the FAA will then detect the cracking and keep the aircraft safe. This process, or procedure is set into being by an approved maintenance program.

Maintenance inspection programs are initially set up between the airline and the manufacturer, and monitored by the FAA. These programs result from past fleet experience and what is known about similar design details operating in similar stress fields. Since no two airlines operate airplanes in the same manner, such as gross weight, flight length, landing weight, descent procedures, and so forth; nor do the airlines inspect or maintain aircraft at the same interval of flight hours. It is then a matter of each operator developing a unique maintenance program with the FAA.

As the operator develops time on a specific fleet, you may find that distress may show up earlier than anticipated and the program will have to be revised. You may find in the case of corrosion some operators may inspect every 2 years and find minor corrosion which is easily cleaned up and at no large cost. Other operators have decided they must go inside an airplane every year because they don't want to put an airplane down for any length of time to clean up corrosion.

The success of the procedure for assuring continued airworthiness of aging jets is dependent on timely detection of major structural damage by the aircraft operator. Both visual and nondestructive testing methods are employed. The procedures and techniques of nondestructive inspection have been developed and evolved over many years, and in this area we have continually supported our customers and our aircraft fleet. Over the past 10 years, investment in this support has averaged approximately $1 million per year, and is expected to continue at a comparable level.

Boeing efforts have included evaluation of new, nondestructive inspection equipment and procedures, development and documentation of techniques to resolve specific inspection problems, onsite and in-house training of airline personnel, and onsite inspection of systems. State-of-the-art equipment, well-documented procedures and training are the keys to successful nondestructive inspections.

In the area of new equipment and procedures, there have been major improvements, mainly in the area of improved electronics, and the integration of microprocessors and easily portable instruments. A result has been to make available handy equipment for field inspections with enhanced capability to detect small damage sites. As an example, the improved instrumentation combined with low-frequency anticurrent probes has markedly improved our capability for backside or hidden component inspections. We expect to continue improvement in nondestructive equipment and techniques to provide greater assistance to finding smaller and smaller damage. I believe that the visual inspection is probably the most important, and there is no substitute for the human set of eyes and feet that are on an airplane.

I think it would be proper at this time to make sure that everybody understands that commercial aircraft are structurally designed with conservative margins of safety; and that is, that the designs are based upon loads which would normally never be experienced in aircraft lifetime, and then a 50-percent margin of safety is added. As an example, Boeing pressure structures are designed for a minimum of 17.2 pounds per square inch when the maximum is never expected to be over 8.6 pounds per square inch. It therefore follows that commercial aircraft can withstand a large degree of damage and still be airworthy. I believe the latest 727 bomb incident in the Near East visibly demonstrates this fact. The described system has shown that time after time it will uncover damage to the aircraft long before it becomes a safety to hazard—becomes a hazard to safe life.

It should be pointed out, though I'm addressing structure, all other systems such as controls, air-conditioning, electrical, and so forth, are viewed in the same manner. We believe that the existing troika system of the FAA, the airlines and the manufacturers will continue to provide safety when all players perform their function in concert with each other. This is a closed-loop system which requires all participants to provide feedback so that timely corrective action may be taken. Laxity on any part of the troika can lead to a reduction in safety.

Many service bulletins are put out by the Boeing Commercial Airplane Co. Our bulletins that I would call preventative and rejuvenating; that is, bulletins which might call for modifying fastener

holes by oversizing, changing a part before it cracks. And I point this out because these bulletins tend to extend the useful life of an aircraft. One could extend the structural life of an aircraft considerably by using this procedure extensively.

However, to see if we can make the system better, we at the Boeing Co. are in the process of developing a plan to increase our knowledge of selected older aircraft by working with the airlines. We are continuing to update the supplemental structural inspection programs on all models. As we continue to get data, we will continue to issue service bulletins and change our product line to improve serviceability of areas that have higher than normal damage rates.

In summary, I'd like to state that a system is in place to keep aircraft safe. It is dependent upon the integrity, the experience, and dedication of the manufacturer, the airline, and the FAA. I think it's a good system. It's not perfect, it may need some fine-tuning on it off and on, but I don't know of a better one at this time.

Finally, I would like to express my appreciation for the opportunity to testify on this complex issue. I hope I've given you some information.

[The prepared statement of Mr. Cosgrove follows:]

STATEMENT OF

BENJAMIN A. COSGROVE

VICE PRESIDENT OF ENGINEERING DIVISION

THE BOEING COMMERCIAL AIRPLANE COMPANY

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

COMMITTEE ON SCIENCE AND TECHNOLOGY

U. S. HOUSE OF REPRESENTATIVES

REGARDING

SAFETY OF AGING AIRPLANES

JUNE 4, 1986

5/28/86

INTRODUCTION - THE SAFETY SYSTEM

There is a system in place in the air transportation industry which is designed to ensure that the mature fleets of commercial air transports are kept flying safely. This system has three major participants: the manufacturers who design, build and support aircraft in service, the airlines who operate, inspect and maintain the aircraft, and the Federal Aviation Administration which establishes rules and regulations, approves the design and maintenance plans and monitors airline maintenance performance. The safety of aircraft depends on this system, and the system depends upon the skill, knowledge, diligence and cooperation of all three major participants.

My testimony today will involve discussions of:

(a) The role of each participant and some of the interplay between groups as they function to provide for a safe air transport system,

(b) The development of maintenance standards for new models,

(c) The procedures to provide for continued airworthiness of aging airplanes,

(d) The development of inspection techniques necessary to assure damage detection,

(e) How well the existing system is functioning, and

(f) New Boeing initiatives to improve airplane safety.

THE AIRPLANE DESIGNER/MANUFACTURER

Structural safety begins at the designer's board with the conception of each new model. It is built on the background and experience of all preceding models and on structural performance data gathered from fleet records from

a multitude of airlines. Boeing commercial jet transports are designed to give 20 years of reliable service, with normal maintenance. Our design goal is to provide a fail safe structure for as long as an airplane is economically serviceable.

To accomplish these goals, airplane structures must be capable of performing safely in a damaged state until the damage can be detected and repaired. Airplanes operate in an environment that is hostile to metals structure. Damage from environmental attack, from fatigue cracking and from accidental causes is accounted for in the design process.

Exposure to atmospheric salts, to water, to runway contamination can cause damage to metal aircraft structure. To help preserve the structural integrity, the metals are protected from environmental damage and corrosion by application of a variety of processes, primers and paints. Although these coatings are durable, they can be inadvertently damaged during commercial service, so inspection and maintenance programs are important.

Damage may also develop from loads imposed by repeated cycles of takeoff, flight, pressurization and landing. Under cyclic loads minute imperfections in materials may form the nucleus of tiny cracks that eventually may grow and degrade structural capability. This phenomena is known as fatigue.

These material characteristics are well known to the structural designer. Engineers are able to determine the strength of structures that have sustained damage. They can also determine the rate at which certain damage will grow. The designer can determine how much damage is safe and how long it takes

to grow to that size. The methodology exists to create designs that are durable, can function safely, and can be maintained economically.

THE FEDERAL AVIATION ADMINISTRATION

The FAA issues a type certificate of airworthiness for new aircraft models, or an amended type certificate of derivative models. Certification is granted only after the aircraft have been demonstrated, through test and analysis, to comply with the FAA regulations regarding certification. Current FAA regulations reflect the latest technology for damage tolerant design. Structure which has been damaged to detectable proportions must be capable of safely carrying extremely high loads . In airline service such loads would normally not be experienced in an aircraft lifetime. As part of the certification process the manufacturer submits analytical and test data to the FAA to verify the residual strength of damaged structures.

MAINTENANCE STANDARDS

Before an airplane is introduced into service, initial maintenance requirements are developed by a Maintenance Steering Committee made up of representatives of the manufacturers and airlines. The process is monitored by FAA specialists. This committee uses a logic decision process outlined in the Maintenance Steering Group (MSG) handbook referenced in FAA Advisory Circular 121-22. The results are issued by the FAA in a Maintenance Review Board (MRB) report which outlines requirements for an airplane model initially starting service. Because each carrier functions in a different manner, each airline negotiates its own unique maintenance program with the FAA. The airline maintenance program must be equivalent or better than the baseline Maintenance Review Board plan. Airline compliance is monitored by an FAA

Principal Maintenance Inspector. Each operators program may be revised at any time based on supportive data from his fleet and subject to FAA approval. The manufacturer also provides the airline operator with continuous maintenance planning data and includes recommended procedures for corrosion prevention.

When damage is detected in service which is not covered by procedures in the approved structural repair manual,both the manufacturer and the FAA are notified. The manufacturer will prepare and release a service bulletin if such damage could be fleetwide and could become a safety concern if left undetected. This will usually involve a special fleet inspection and a repair procedure. The FAA will release an Airworthiness Directive (AD) requiring the operator to perform the Service Bulletin procedure. If a design change is warranted, the manufacturer corrects the problem for future production units.

CONTINUING AIRWORTHINESS

The procedure for assuring continued airworthiness of aging commercial jets has been under active development since 1968, when a joint FAA/Industry committee was formed to review the characteristics of older pressurized piston, turbo-prop and jet transport aircraft. The committee completed its work in 1970 and advisory circulars were issued providing guidance material covering structural maintenance of five airplane models. This work continued in the mid and late 70's with the formulation of procedures to extend the serviceable life of aging airplanes. Both the FAA and the CAA (United Kingdom) require that structures of older models be audited using modern technology and reflecting current service experience. When necessary, supplemental structural inspections would be required to assure timely damage detection. This

procedure has been completed for the Boeing model 707 in 1979 and for models 727, 737 and 747 in 1983. A Supplemental Structural Inspection Document was published for each model and released to all Boeing operators. These inspections are now mandatory for U. S. operators under an FAA Airworthiness Directive. This effort involved a Boeing investment of over 15 million dollars and we plan future investments to extend coverage to our later models. These documents require frequent review to assure consistency with the latest fleet information on damage patterns.

The question has frequently been asked, "How old can an airplane be allowed to get before it becomes unsafe?" Most industry experts believe that as each aircraft becomes older, the frequency of damage will increase and correspondingly, the costs of inspections and repair may also increase. This trend may be halted or reversed if aging structures are rejuvenated periodically by modification programs. In any case, the existing troika system does provide safety when all players perform their function in concert with one another. It is a closed loop system which provides feedback to all participants so that timely corrective action may be taken.

STRUCTURAL INSPECTIONS

As explained previously, the success of the procedure for assuring continued airworthiness of aging jets, is dependent on the timely detection of major structural damage by the aircraft operator. Both visual and non destructive testing methods are employed. The procedures and techniques of Non Destructive Inspection (NDI) have developed and evolved over many years, and in this area we have continually supported our customers and our aircraft fleet. Over the past 10 years investment in this support has averaged approximately

$1 million per year and it is expected to continue at comparable levels. Boeing efforts have included: Evaluation of new NDI equipment and procedures, development and documentation of techniques to resolve specific inspection problems, on site and in house training of airline personnel, and on site inspection assistance,. State of the art equipment, well documented procedures and training are keys to successful NDI.

In the area of new equipment and procedures, there have been major improvements, primarily in the area of improved electronics and the integration of microprocessors into easily portable instruments. The result has been to make available "handy" equipment for field inspection with enhanced capability to detect small damage sites. As an example, the improved instrumentation combined with low frequency eddy current probes has markedly improved our capability for "backside" or hidden component inspection. We expect continued improvement in NDI equipment and techniques to provide greater assurance of finding smaller and smaller damage.

SAFETY SYSTEM PERFORMANCE

Findings of damage on older 747's have been much in the news in recent months. The extent of damage reported has been within that which the designer considered in the initial design. In each case the safety system has functioned exactly as it was intended. All damage has been detected and corrected before becoming a safety issue. Service Bulletins and Airworthiness Directives are now in preparation to cover each aircraft that approaches the damage threshold.

The overall safety record of the free world commercial aircraft fleet has been and continues to be extremely good. We continue to strive for perfection. There have been 8800 jet transports manufactured in the free world in the past 30 years. Boeing has produced almost 5000 of these. There are 3500 aircraft in service in the United States alone. Worldwide accident rates have fallen and have leveled out at about 2 per one million departures. Of all accidents where the cause is known, structural failure and faulty maintenance contribute less than 4% (one in ten million departures), a total of nine accidents worldwide in 25 years . Of the nine only one fatality accident has been recorded within the United States.

NEW BOEING INITIATIVES

What is Boeing doing to assist the operators in maintaining the safety of their aging aircraft? We are developing an improved plan to review the structural condition of selected high time fleet airplanes. With the airlines cooperation, we plan to provide engineers for fleet damage evaluations at convenient inspection opportunities. In addition we are continuing to update our Supplemental Structural Inspection programs to account for new cracking pattern information from fleet service and from Boeing test programs. Boeing is correlating the results of its test programs with the information that is accumulating from in-service inspections. We continue to issue Service Bulletins and make production changes to improve serviceability of areas with higher than normal damage rates. In addition, we are honing our techniques and procedures for non-destructive testing to provide operators with more reliable and more economical tools to distinguish smaller structural damage sites. We have in place publications and schools to train and certify NDI technicians in the proper procedures and most advanced techniques of non-destructive inspections.

To conclude, I believe the long term well being and surviveability of aircraft manufacturers and the main operators depends on a diligent maintenance program and continued improvement of the safety record that we have achieved. Let me repeat that the air transportation industry has a system in place to keep airplanes flying safely. This system requires the cooperation and dedication of the FAA, the manufacturers and the airlines.

Mr. BROWN. Thank you, Mr. Cosgrove. We hope that it will be constructive, also, either in determining if there are any unmet needs or, if we find that there are any, reassuring all the concerned parties, and that includes the public as well, that our system continues to be the best in the world, and that can have some value in itself.

Mr. Lewis.

Mr. LEWIS. What is the normal procedure for Boeing to put out a service bulletin for the possibility of making a fatigue inspection on the FNI's or the tail assembly of any of their aircraft? You have already in the design come up with a half-life. You've run it, you've bent it, you've twisted it—you've done everything for hundreds of hours and things like that. When do you feel—do you continue anything after that to find any additional development after that, after the plane is determined—being certified?

Mr. COSGROVE. Well, generally speaking, we are highly dependent upon the airline to come up and say to us: Hey, you know we see something funny going on here. Let me give you an example. Every once in a while some airline will come in and say we see a lot of working of a rivet at a particular joint one way or another, and so we have field service representatives on the site and we'll say, well, hey, go take a look at this. And if he starts saying, well, this is something different than I've ever seen before, why we may say, well why don't you pull out some fasteners or run an x ray or something and let's see what's going on there because our experience doesn't tell us that this area might—we should be looking in this particular area. So as a for instance, why we may say pull some fasteners, run an anticurrent check; and if we find something, then what we'll do is we probably will go out with a service bulletin, which would be an inspection, and we might do it by phone or we might say, hey, we'd like to look at a group of 10 airplanes that have got a certain time on them, and so forth, down the line, and see if there's something going on. It could be from, maybe, corrosion or something else, but we'll go and take a look at a group of airplanes in that same flight time or in cycle time.

Mr. LEWIS. Does the airline—do the airlines or do repair stations, do you have—do they contract with Boeing to have field representatives there on a full-time basis or a part-time basis or not at all?

Mr. COSGROVE. Let us speak to the airlines first. At their bases we, as a matter of selling an airplane, have people go to those bases, and we will keep them there as long as they desire. Sometime the contract runs out and we would still renew the contract. We have representatives out in the field all over the world.

Mr. LEWIS. I see. How about on the repair stations? Any repair stations?

Mr. COSGROVE. Well, if you want to call—if you wanted to call San Francisco, United, a repair station, the answer would be yes. Yes, because they do other people's work, also, and that can be a repair station. Yes.

Mr. LEWIS. I have no further questions, Mr. Chairman. Thank you, Mr. Cosgrove.

Mr. GLICKMAN [presiding]. Thank you, Mr. Cosgrove.

As you know, I have a large facility of the Boeing Co. in my district.

Mr. COSGROVE. Yes.

Mr. GLICKMAN. So I'm doubly glad to have you here.

What is the design life of an aircraft? Is it 20 years? 50,000 hours? What?

Mr. COSGROVE. Well, we make a verbal statement that says with normal maintenance this aircraft is designed for 20 years. OK? Then you take the type of aircraft that you're talking about. Let's take one extreme end of it, like a 747. Twenty years for a 747 might be someplace in the neighborhood of 60,000 to 70,000 hours, but it'll only be 20,000 landings.

But if you take the other end of the extreme, which is the 737, which flies every 20 minutes, it'll have 70,000 flights in only 45,000 hours. Now that is a goal which we set up for ourselves and we design all our aircraft to that particular goal. What you'll generally find is that the aircraft is considerably better than that. There are some part of it that are considerably worse than that and we would want to get those real quick. But fundamentally, you'll generally find the aircraft will go further than 20 years; in fact, we're getting an opinion, or looking at the fleet that may be closer to 22 to 25 years before you start running into a lot of cost for maintenance purposes.

Mr. GLICKMAN. OK. So, but an airplane can fly longer than that——

Mr. COSGROVE. Oh, yes.

Mr. GLICKMAN [continuing]. If you do what has to be done.

Mr. COSGROVE. Absolutely.

Mr. GLICKMAN. And the question is of expense——

Mr. COSGROVE. That is correct.

Mr. GLICKMAN [continuing]. More than anything else. Like we have the short DC–9's and the short 727's that are clearly over 20 years old now.

Mr. COSGROVE. Oh, yes.

Mr. GLICKMAN. And they are flying but at the increased cost of major replacements then.

Mr. COSGROVE. That's correct. That's——

Mr. GLICKMAN. And——

Mr. COSGROVE. Excuse me.

Mr. GLICKMAN. Go ahead.

Mr. COSGROVE. Well, all I was going to say is yes. It becomes an economic venture at a certain point, whether it's 20 years, 18 or 25, that you'll start seeing a rise in the maintenance that you probably perform on an aircraft.

I think one of the other things that probably happens more frequently than just a rise in the cost of the maintenance is the fact that you'll be—all of a sudden you'll be out of the base with, let's say, 300 passengers, or 200 passengers and all of a sudden you've got an inspection and you say, well I've got to go do something, you know; and that becomes very expensive when you take a load of passengers off.

Mr. GLICKMAN. That's what happened with Mr. Brown the other day that he was talking about.

Mr. COSGROVE. I can believe that. It happens every once in a while, and that's a bad scene when it happens to the airlines.

Mr. GLICKMAN. So therefore there's no reason why a 727 properly maintained couldn't be flying 40 or 50 years?

Mr. COSGROVE. That is correct. Absolutely. In fact, you have DC-3's that were probably built about 1933 or somewhere like that that are still flying. But every 10,000 hours they replace wind joints, and they've been doing it for years.

Mr. GLICKMAN. OK. Thank you very much.

Mr. COSGROVE. You're welcome.

Mr. BROWN. We have no further questions, Mr. Cosgrove. Thank you very much for your testimony.

Mr. COSGROVE. Thank you.

Mr. BROWN. Our next witness is Mr. William W. Hoover, executive vice president for operations and safety of the Air Transport Association.

STATEMENT OF WILLIAM W. HOOVER, EXECUTIVE VICE PRESIDENT, OPERATIONS AND SAFETY, AIR TRANSPORT ASSOCIATION OF AMERICA, WASHINGTON, DC, ACCOMPANIED BY VERN BALLENGER, ASSISTANT VICE PRESIDENT, ENGINEERING AND MAINTENANCE

Mr. HOOVER. Thank you, Mr. Chairman. It's a pleasure to be before you today. I'm accompanied by Mr. Vern Ballenger, who is assistant vice president of engineering and maintenance. We're pleased to have this opportunity to talk about the maintenance of mature airline aircraft based on over 50 years of experience gained by our members.

With your permission, sir, I will submit my full statement for the record. I would like to hit a few key points.

Mr. BROWN. Without objection, the full statement will be included in the record.

Mr. HOOVER. The operational and economic life of a modern jet aircraft is affected by factors such as total flying time, total landings and takeoffs, current mission requirements, customer appeal and acceptance, direct operating costs, state-of-the-art technological advances, and noise constraints. The chronological age of an airplane is a determinant of operational and economic life only to the extent that it affects one or more of the factors I just mentioned.

The airlines are, of course, responsible for maintaining their aircraft regardless of chronological age in a manner that will ensure continued safe, reliable operation. The airline maintenance programs are designed to ensure inspection, repair or replacement of aircraft components as they reach specified levels of flight hours, flight cycles or calendar time. These maintenance programs are initially based on tests and recommendations of the manufacturers, but are revised thereafter based on operator and industry experience.

The maintenance programs applied to any given aircraft type can be divided into three basic categories: systems and components, cabin interiors, and aircraft structure.

The first category, systems and components, include engines and landing gear; and these and other major systems and components accumulate flight hours and cycles, experience and manufacturer's data are used to determine the intervals at which they are to be

inspected or replaced. Continuing repair, replacement and modification ensures continuing safe and reliable operations. Thus, the major systems and components on a mature aircraft fleet may not be chronologically older than those on a much younger fleet. In fact, many systems and components installed on older aircraft are far more reliable than the original components because of continuing upgrading through modification.

The second area addressed by maintenance programs involves cabin interiors. Maintenance of cabin interiors is based on factors other than accumulated flight hours and cycles. Cabin interior maintenance programs restore the appearance and functionality in accordance with both safety and cosmetic standards.

The third category of maintenance programs, one that is directly affected by flight hours and cycles, involves the basic aircraft structure. Commercial jet aircraft are subjected to comprehensive fatigue, static, and flight testing before entering commercial service. This testing, which is performed in conjunction with certification of the aircraft type by the FAA, is the basis for the development of initial structural maintenance programs. Therefore, manufacturers and airlines share their test data and operating experience to develop more refined inspection procedures and maintenance intervals that are incorporated in revised structural maintenance programs. These programs are reviewed and approved by the FAA.

Higher levels of flight hours and cycles are not a limitation on the continued safe operation of aircraft so long as the industry, in cooperation with the FAA, continues to develop and implement aggressive inspection programs to assure early detection of problems associated with the more extended useful life now becoming common among the carriers.

For example, the early group of Boeing 727 aircraft operated by many airlines have been in service for over 20 years. Over the years the airlines have accomplished numerous major modification programs on these aircraft. One Air Transport Association member airline spent approximately $100 million on structural life extension programs during the 1973–75 time period. This same airline also reported a 55-percent increase in direct airframe maintenance costs for their 727 fleet between 1980 and 1985. Structural life extension programs will continue as long as the aircraft can be operated economically.

Experience has shown that each airline can benefit from the intelligence provided by other operators. For this reason, we believe that all airlines operating a specific type of aircraft should participate in regular periodic review forums conducted by the aircraft manufacturer to examine and exchange information and technical analysis relative to the aircraft in question.

In summary, neither chronological age nor cumulative flight hours and cycles limit the continued safe operation of an aircraft. Progressive incorporation of modifications, together with continuing inspection and refurbishment programs, serves to extend an airplane's useful life until increased costs, marketing factors, or environmental considerations dictate its retirement from service. These considerations are done in cooperation with the manufacturers, the airline operators and the Government. As already said, the Douglas DC–3, which was first flown in commercial service some 50

years ago, is perhaps the best example of a chronologically old type of aircraft that is still providing safe air transportation.

Thank you, sir. That concludes my remarks.

[The prepared statement of Mr. Hoover follows:]

Statement of William W. Hoover
Executive Vice President - Operations and Safety
Air Transport Association of America before the
House Science and Technology Committee, Subcommittee
on Transportation, Aviation and Materials on the
Maintenance of Mature Airline Aircraft
June 4, 1986

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE

I am William W. Hoover, Executive Vice President - Operations and Safety for the Air Transport Association of America. I am accompanied today by Vern W. Ballenger, Assistant Vice President - Engineering and Maintenance. I am pleased to have this opportunity to talk about the maintenance of mature airline aircraft based on over 50 years of experience gained by our members.

The operational and economic life of a modern jet aircraft is affected by factors such as the following:

- Total flying time
- Total landings and take-offs (flight cycles)
- Current mission requirements
- Customer appeal and acceptance
- Direct operating costs
- State-of-the-art technological advances
- Noise constraints

The chronological age of an airplane is a determinant of operational and economic life only to the extent that it affects one or more of the factors set forth above.

The airlines are, of course, responsible for maintaining their aircraft regardless of chronological age in a manner that will ensure continued safe, reliable operation. This is done by means of maintenance programs developed by airlines and manufacturers and approved by the FAA. These programs are tailored specifically for each aircraft type, and for each operator's mission and operating environment for the aircraft.

The maintenance program for any given type of airplane must account for the effects of flight hours, flight cycles and calendar time. An aircraft operated in long-haul service may accumulate 10 to 12 flight hours per day with only 1 to 2 take-off and landing cycles. On the other hand, an aircraft of the same type operated in shorter haul service may accumulate only 7 to 10 flight hours per day with 6 to 8 take-off and landing cycles. In the case of low utilization aircraft, some maintenance items, such as corrosion, may be controlled by calendar time. As a result, the maintenance requirements of airplanes of the same chronological age may be significantly different because of variations in the number of flight hours and landing cycles accumulated during a given calendar time period. In addition, the effects of unique environmental conditions must be considered.

Airline maintenance programs are designed to ensure inspection, repair or replacement of aircraft components as they reach specified levels of flight hours, flight cycles or calendar time. These maintenance programs are initially based on tests and recommendations of the manufacturers, but are revised thereafter based on operator and industry experience. For example, such experience may dictate changes in the aircraft inspection intervals. Experience may also give rise to revised maintenance procedures, calling for design improvements, and repair or replacement of components, systems and structure of the aircraft on a timely basis.

As noted above, factors other than flight hours and cycles, such as the environment in which an aircraft is operated, may also give rise to special maintenance requirements. For example, significant operations in tropical climates make corrosion detection, correction, and prevention an important part of an aircraft maintenance program.

The maintenance program applied to any given aircraft type can be divided into three basic categories: (1) systems and components; (2) cabin interiors; and, (3) aircraft structure.

The first category -- systems and components -- includes the engines and landing gear. As these and other major systems and components accumulate flight hours and cycles, experience and manufacturer's data are used to determine the intervals at which they are to be inspected or replaced. Continuing repair, replacement and modification ensures continuing safe and reliable operation. Thus, the major systems and components on a mature aircraft fleet may not be chronologically "older" than those on a much younger fleet. In fact, many systems and components installed on older aircraft are far more reliable than the originals because of continuous upgrading through modifications.

The second area addressed by maintenance programs involves cabin interiors. Maintenance of aircraft interiors is based on factors other than accumulated flight hours and cycles. These include the number of passengers that occupy the seats each day, the number and times that meals are served from the galleys, and other factors that give rise to wear and tear of the bulkheads, carpet, upholstery, lavatory components, etc. Cabin interior

maintenance programs restore the appearance and functionality in accordance with both safety and cosmetic standards.

The third category of maintenance programs, one that is directly affected by flight hours and cycles, involves the basic aircraft structure. Commercial jet aircraft are subjected to comprehensive fatigue, static and flight testing before entering commercial service. This testing, which is performed in conjunction with the certification of the aircraft type by the FAA, is the basis for the development of the initial structural maintenance program. Thereafter, manufacturers and airlines share their test data and operating experience to develop more refined inspection procedures and maintenance intervals that are incorporated in revised structural maintenance programs. These programs are reviewed and approved by the FAA.

The significance of higher levels of hours and cycles on a particular aircraft fleet are evaluated on an on-going basis by means of a Supplemental Inspection Program that extends to all significant structural elements of an aircraft. This program, developed by means of cooperation among operators and manufacturers and the FAA, makes available to every participant the cumulative results of the industry's inspection and testing programs. This data is also used by each aircraft manufacturer to prescribe programs of additional inspections which ensure prompt detection and correction of any new problems. These programs use a combination of visual and sophisticated non-destructive inspection methods such as X-ray, radioisotope and eddy current to detect defects.

Higher levels of flight hours and cycles are not a limitation on the continued safe operation of an aircraft, so long as the industry, in cooperation with the FAA, continues to develop and implement aggressive inspection programs to assure early detection of problems associated with the more extended useful lives now becoming common among the carriers.

For example, the early group of Boeing 727 aircraft operated by many airlines have been in service over 20 years. The high time aircraft has well over 50,000 flight hours and 40,000 flight cycles. Over the years, the airlines have accomplished numerous major modification programs on these aircraft. These programs, developed in cooperation with the manufacturer, include both structural modifications and corrosion prevention processes to ensure continued structural integrity. One ATA member airline spent approximately $100 million on structural life extension programs during the 1973 - 1985 time period. This same airline also reported a 55 percent increase in direct airframe maintenance costs for their 727 fleet between 1980 and 1985. Structural life extension programs will continue as long as the aircraft can be operated economically.

Experience has shown that each airline can benefit from the intelligence provided by other operators. For this reason, we believe that all airlines operating a specific type of aircraft should participate in the regular periodic review forums, conducted by the aircraft manufacturer, to examine and exchange information and technical analysis relative to the aircraft in question. These meetings enhance the quality of the data available and enable the industry to devise even better maintenance and modification programs in the future.

In summary, neither chronological age nor cumulative flight hours and cycles limit the continued safe operation of an aircraft. The progressive incorporation of modifications, together with continuing inspection and refurbishment programs, serves to extend an airplane's useful life until increased operating costs, marketing factors or environmental considerations dictate its retirement from service. The Douglas DC-3, which was first flown in commercial service 50 years ago, is perhaps the best example of a chronologically old type of aircraft that is still providing safe air transportation as a result of airline maintenance programs.

This concludes my statement. We would be pleased to respond to any questions you may have.

Mr. BROWN. Thank you very much, Mr. Hoover.

Do you have anything you wanted to add, Mr. Ballenger?

Mr. BALLENGER. Only that, in listening to Mr. Cosgrove's presentation and Tony Broderick's presentation, I agree wholeheartedly with what those gentlemen said.

Mr. BROWN. Thank you.

Mr. Lewis.

Mr. LEWIS. Yes, sir. Thank you, Mr. Chairman.

Why has the average age of airline fleets increased so much in the past recent years? What factor has influenced this?

Mr. HOOVER. Well, I think among other things it's been demonstrated that the aircraft can be operated with certainty and safety. It has economic return that is still such that there's nothing that suggests that you can replace it and achieve a greater economy. I think the size of the aircraft, in particular is a good example. I think deregulation has caused a reinterest in the smaller sizes of the air transportation aircraft, and therefore they've been continued past when people thought that perhaps we would see the larger aircraft taking over more of the market.

Mr. LEWIS. Could you tell us why airlines are devoting less of their maintenance budgets, or less of their operations budgets, I should say, to aircraft maintenance in recent years?

Mr. HOOVER. Well, I think you have to look at those maintenance costs really on the basis of individual airlines, but let me make some general statements. In recent years we have certainly seen that labor costs have, if not gone down, at least been contained. We have seen improvements in the reliability of certain components. And I think that any CEO of an airline should be—should expect, from his chief of maintenance, that he be able to get higher quality maintenance at lower cost. And therefore, I do not see that as some would assert that maintenance costs are going down because people are shaving the margin of safety. Quite the contrary. I think there are very good and valid reasons why maintenance costs should be going down, because we know how to do things better today than we did before.

Mr. LEWIS. In your view, Mr. Hoover, has the FAA's maintenance system and monitoring program developed into a system that is complex and difficult to implement effectively?

Mr. HOOVER. Well, first of all, we heartily endorse the FAA's program for inspection. We want them to have quality inspectors, well trained; and we want them to have a consistent inspection program, so that we can understand what is wanted of us. I think that in my dealings with the senior leadership of the FAA I believe that they are sincere and are bringing into place programs and system which will meet those objectives of quality and consistent inspections, and we think that that's what's needed.

However, I would like to comment that I think the true value or the true merit of the safety program is not the fact that you've got a watchdog looking over your shoulder. It's the fact that our individual member airlines have strong programs internal to themselves, and that there's a certain peer pressure brought to bear by those members of the Air Transport Association such that we're concerned, at the bottom line, the most about safety of anyone.

Mr. LEWIS. Do you feel that the FAA maintenance surveillance system could be improved?

Mr. HOOVER. I think that they are in the process of developing guidelines which perhaps have not been kept current, and I think that would be a very helpful undertaking such that we have a consistent basis for interpreting the requirements of the inspection program. So we endorse that effort. And in that sense, I think it can be improved; yes.

Mr. LEWIS. Mr. Chairman, I don't have any further questions for either gentleman. Thank you.

Mr. BROWN. Do you, with regard to this question of relative emphasis on an inspection program, do you think there would be merit in concentrating more of the inspections on new airlines or rapidly expanding airlines, or do you think this is adequately addressed in the existing program?

Mr. HOOVER. I probably don't have a real basis to answer that, other than intuitively I think you want to ensure that a new airline fundamentally has the requisites and the programs and the system incumbent in itself that it can meet the record that has been established over the years by the established airlines.

Mr. BROWN. This question of the excellent record of the old DC–3's has been brought up several times, including in your own testimony. What, in your view, has made these airplanes such reliable aircraft that they can be used over such an extensive period of time? Is it—was there something special about the way they were designed and built, or is it what you would say is the normal result of the excellence of our existing inspection and maintenance program?

Mr. HOOVER. Probably both. Engineers tend to be very conservative. I think that the DC–3 was designed at a time when, perhaps, we didn't know as much about aircraft design as we do today, and I'm sure that, you know, there was a great deal of conservatism built into that design. I think that in the ensuing years that the inspection and maintenance programs that have been developed have just been able to build upon what was a basically reliable design to start with.

Mr. BROWN. Of course, in addition to the question of safety of the aircraft and long life, it's almost a miracle that they can maintain an economic niche and provide a level of service at a cost which is still competitive for whatever niche they're fulfilling. I don't know how they're being used today. Obviously, they're doing something right. They must be making money, in other words.

Mr. HOOVER. That's the bottom line. Yes, sir.

Mr. BROWN. I have no further questions. We appreciate your contribution very much, Mr. Hoover, and, Mr. Ballenger, and if we need you further, why, we'll be back in touch with you.

Mr. HOOVER. Thank you, sir. And I'm sure you will.

Mr. BROWN. Thank you very much, and the subcommittee will be adjourned.

[Whereupon, at 12:05 p.m., the subcommittee was adjourned, to reconvene subject to the call of the Chair.]

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